AUGUST 1956

Power Engineering

Special Report:
WORLD DEVELOPMENTS IN ELECTRIC POWER SYSTEMS

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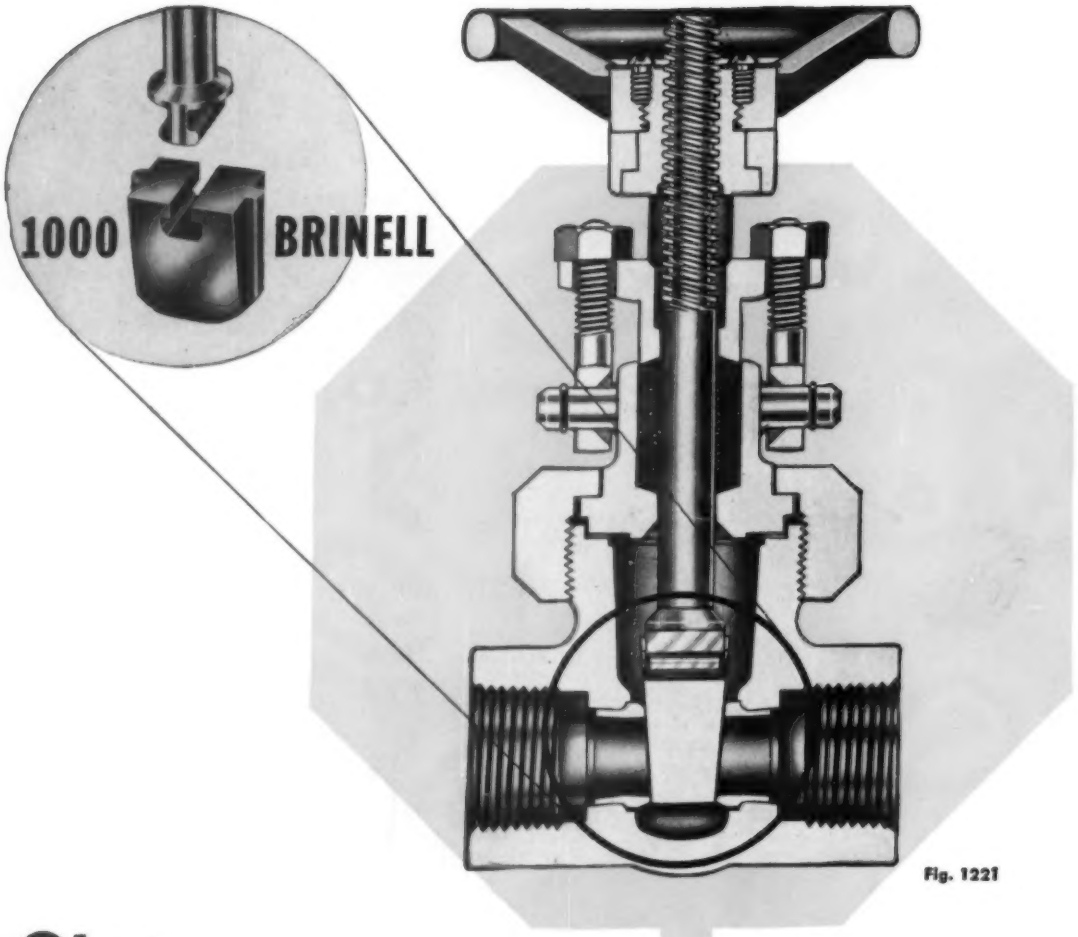

Fig. 1221

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Here's a wedge as hard as flint . . . so hard that it's undamaged by pipe cuttings, scale or grit. It's the only trim we know of which will successfully withstand the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling. This wedge is *13% chrome stainless steel hardened up to 1000 Brinell.*

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WADSWORTH, OHIO

OIC VALVES

FORGED & CAST STEEL,
BRONZE & IRON,
LUBRICATED PLUG VALVES.

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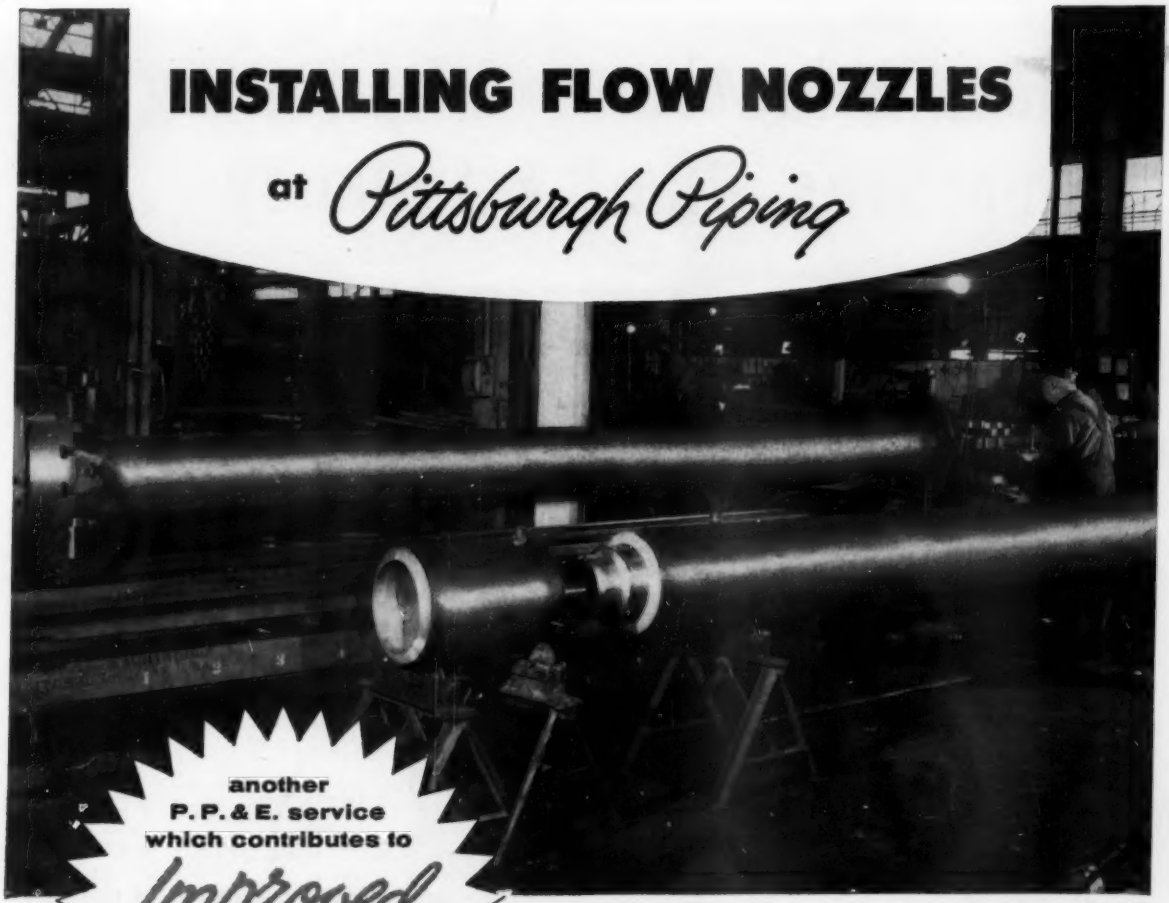
INSTALLING FLOW NOZZLES

at *Pittsburgh Piping*



another
P. P. & E. service
which contributes to
Improved
HIGH-TEMPERATURE
HIGH-PRESSURE
PIPING

Pittsburgh Piping's precision installation of flow nozzles in high-pressure piping is the result of extremely skillful machining, fitting, and welding by experienced craftsmen. This is another example of advanced techniques — available at Pittsburgh Piping — which provide greater safety, higher efficiency and longer life from high-pressure, high-temperature piping.

Precision fitted flow nozzles; largest shown is for 16" main steam line; 4" and 6" sizes in foreground are for boiler feed lines.

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PP-19

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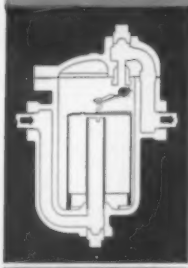
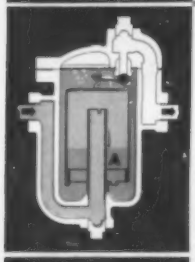
How Armstrong Trap Design Improves Plant Efficiency . . .

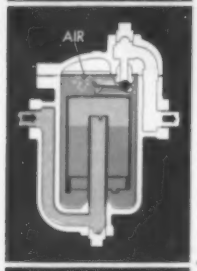


1 When trap is first installed, the inverted bucket is down and the valve is wide open. The large clearance between valve and seat minimizes restriction to condensate flow, contributing to large capacity.

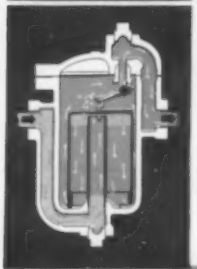
2 When steam is turned on, note how condensate (solid color) flows down between bucket and trap body, then up and out through orifice. Dirt is held in suspension and washed out when valve opens.



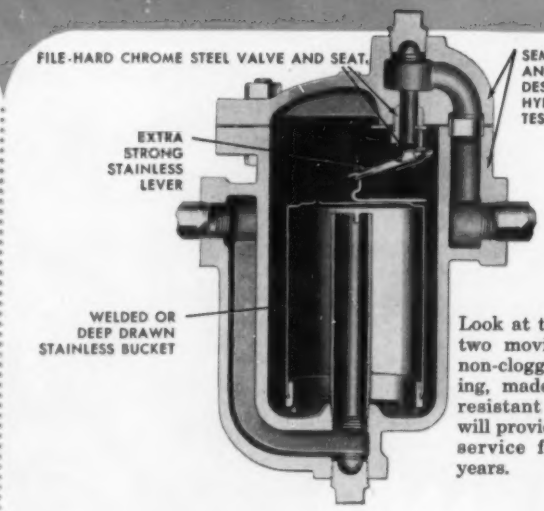
3 When steam reaching trap displaces less than ⅔ of the water in the bucket, it floats, closing the valve. Generous safety margin (dimension A) insures that steam will never reach trap orifice.



4 When more condensate enters trap, the bucket loses buoyancy and pulls on valve lever. (Note how incoming air passes through bucket vent and collects at top of trap, awaiting discharge.)



5 When weight of bucket times leverage overcomes pressure on valve, trap opens, creating momentary pressure drop that "pumps" condensate and non-condensibles from unit being drained.


FILE-HARD CHROME STEEL VALVE AND SEAT.
SEMI-STEEL BODY AND CAP. 250 LBS. DESIGN PRESSURE—HYDROSTATIC TESTED AT 500 LBS.
EXTRA STRONG STAINLESS LEVER
WELDED OR DEEP DRAWN STAINLESS BUCKET

Look at this trap. Only two moving parts. It's non-clogging, non-sticking, made of corrosion resistant materials. It will provide trouble-free service for years and years.

Time-Tested Inverted Bucket Principle Provides Five Cost-Reducing Benefits:

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3. Low Fuel Consumption—non-productive radiation losses are minimized because condensate is discharged at steam temperature as fast as it accumulates in the trap—you get more production per hour and per unit of fuel. And, there is no steam loss through the trap orifice.

4. Continuity of operation—the trap always opens for condensate; the simple, sturdy, self-cleaning mechanism insures continuous operation between inspections without interruption of processing.

5. Low Maintenance—no trap has ever gained so enviable a record for trouble-free service—ask anyone who has kept records.

Free: Steam Trap Book—
44 helpful pages on trap selection, installation maintenance, physical data and prices. Call your local Armstrong Representative or Distributor, or write:

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ARMSTRONG *Inverted Bucket* STEAM TRAPS

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NBP BPA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

WILLIAM F. RYAN, vice president, director, and senior consulting engineer of Stone & Webster Engineering Corp., has been nominated to serve as the 1956–57 president of the American Society of Mechanical Engineers, it was announced at the Society's semi-annual meeting in Cleveland.

The new president-nominee of ASME holds two degrees from Harvard College, an AB degree awarded in 1911 and an MME degree conferred in 1913. In 1954, Catholic University of America conferred upon him the degree of ScD.

Dr. Ryan joined Stone & Webster Corp. in 1929 as a mechanical engineer. He was named a vice president in 1950, after having served as assistant chief mechanical engineer, assistant engineering manager, and engineering manager.

William F. Ryan

He joined ASME in 1917 and has served in numerous committee, divisional and delegate assignments for the Society. Currently, he is ASME representative on the Engineers Joint Council-Engineering Council for Professional Development Committee on Practice of Engineering and as advisory member of the Power Division Executive Committee.

He is also active in other national and international organizations, including the NSPE, ASEE, United States Naval Institute, American Ordnance Association, ECPD, International Electro-Technical Commission, and the Harvard Engineering Society. He is the author of numerous technical papers in the fields of heat and power and professional ethics. He holds a patent on a dual-circulation boiler.

GAS TURBINE-GENERATOR set rated 21,500 kw will be manufactured by the General Electric Co. for Electricidad de Caracas, a utility serving the capital of Venezuela. This new unit will be the largest gas turbine yet manufactured in the Western Hemisphere. It will be installed in the new El Convento station of Electricidad de Caracas and used for daily peak load operation. The gas turbine will use natural gas as fuel, but is also designed for dual fuel operation, changing from gas to distillate oil as necessary. The unit of simple-cycle, single shaft type will be designed for completely automatic, unattended operation. Nominal rating of 21,500 kw is for operation at an air temperature of 68 F at an altitude of 3,000 ft above sea level. It is scheduled for shipment in 1957.

CEREMONIES at the Pacific Switchgear Division plant of Federal Pacific Electric Co., marked the completion of the 1000th oil circuit breaker with rating of 115 kv or higher. The breaker, rated at 5,000,000 kva at 230 kv, was presented to N. R. Sutherland, president of Pacific Gas & Electric Co. during open house ceremonies attended by AIEE members during their west coast meeting.

MUSIC by the Numbers: — Datatron, a quarter-million-dollar electronic brain, has composed history's first ballad by automation. Ending a month of rumors, the ElectroData Division of Burroughs Corp. has announced that its mathematicians have succeeded in programming its superfast computer to write melodies automatically at

In official ceremony June 22 at Chicago headquarters of National Safety Council, George MacDonald, Senior Consulting Engineer of the Council (left) presents to Chester R. Earle, executive editor of POWER ENGINEERING, the plaque recording the Council's 1955 Public Interest Award for exceptional service to safety. This service consisted of publication in POWER ENGINEERING of numerous articles on aspects of power plant safety, as noted on page 3, June issue

a rate of 1,000 per hour, based on arithmetic note selection. Electro-Data officials emphasized that music-by-the-numbers is "an experiment of mathematical importance only," carried out in Datatron's spare time. Although chiefly preoccupied with scientific and business computing, Datatron has performed other human high-jinks lately — including correct forecasts on the outcome of four New Year's Day football bowl classics.

SAN DIEGO Gas and Electric Company has ordered a 100,000 kw steam turbine-generator unit for its Encina station located at Carlsbad, Calif., from the General Electric Co. A tandem-compound, double-flow, reheat turbine with 23-inch last stage buckets will drive the generator, which is rated at 129,705 kva. The turbine will operate under an initial steam pressure of 1450-psig at 1000 F, with reheat temperature of 1000 F.

Andrew W. Kramer, editor (left), and Richard H. Morris, editorial director, POWER ENGINEERING, stand before transmission line map at 5th World Power Conference held in Vienna, Austria, June 17 to 24, 1956. Their report on the features of the Conference will appear in our September issue

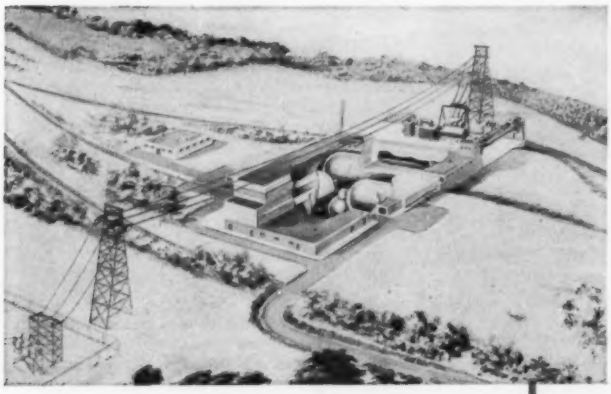
HAROLD J. PETERSEN was elected May 15, 1956 to the position of vice president and power consultant for United Engineers & Constructors Inc. Immediately before joining United Engineers, he had served since 1937 as chief mechanical engineer for the Tennessee Valley Authority at Knoxville, Tenn. During this period, he supervised the designing of 7,500,000 kw of power equipment at seven TVA steam plants.

Harold J. Petersen

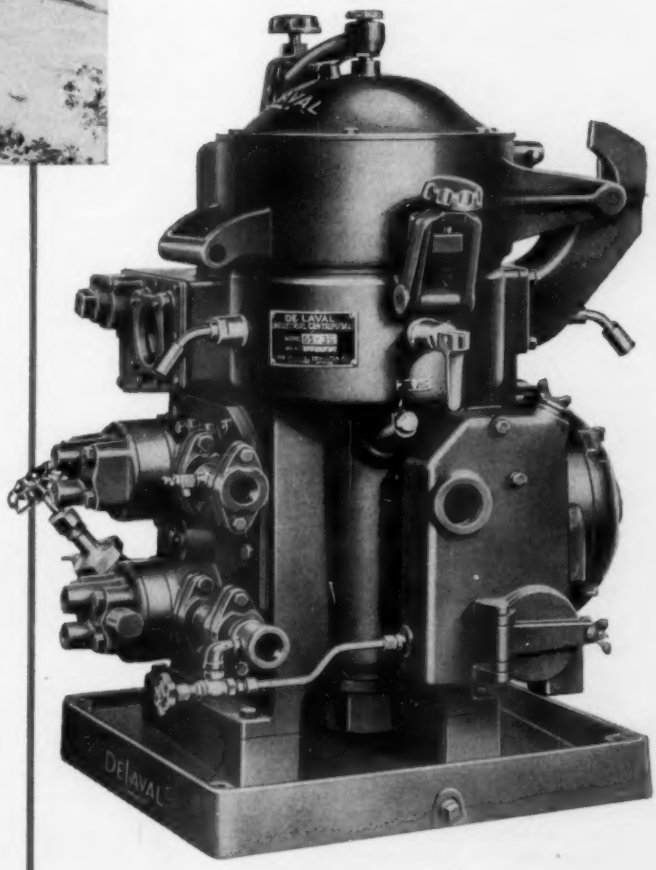
Mr. Petersen was born in Davenport, Iowa, in 1900. He was graduated in 1923 from Iowa State College at Ames, Iowa, with a B.S. in Civil Engineering. His first position was with U. S. Coast and Geodetic Survey. He then served as office engineer for Watson-Garris Consulting engineers, as chief draftsman for the City of Miami, Fla., and later, for three years, served in Southeastern Engineering Co. on the design of the Gorgas plant of Alabama Power Co. and Atkinson Steam plant of Georgia Power Co. Followed five years as mechanical engineer for Safe Harbor Water Power Corp., and a year designing an industrial water supply system for the City of Birmingham.

Mr. Petersen is a member of Sigma Chi, and ASME and former chairman of the East Tennessee section of ASME. He has presented many papers on power plant engineering before American Power Conference, ASME and AIEE. He has also written numerous articles in POWER ENGINEERING, *Combustion, Mechanical Engineering.*

WHAT'S DE LAVAL GOT TO DO WITH NUCLEAR FISSION?...



PLENTY!



Right now De Laval is making an important contribution to the efficiency of America's first commercially-built, full-scale atomic power plant for the generation of electricity.

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In the atomic age ... De Laval will continue its major contributions!

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WHAT THEY TELL US

THIS COMMENT on the question and answer, Reason for the Brush, *page 6, June 1956 issue*, came to us from a reader who has had more than 50 years of active experience. He said that while operating close to the salt water where d-c from electric railway return currents have a "habit of detouring" there was an ever-present danger; he recalled:

> In one particular instance, where the addition of a carbon brush was not relieving the situation, it was found that the resistance of the brush itself was sufficiently high to cause the "stray current" to seek other paths. This was overcome by use of a copper brush made up of copper gauze which cured the condition completely. The use of a low-reading ammeter and sometimes a milliammeter indicated at once the effect of the brush as a mitigating measure.

IT IS EARNESTLY HOPED that the implications of your article, Pumped Storage Forges Ahead, *March 1956 issue*, will induce efforts to make use of all our available replaceable natural resources, wrote one of our readers. He said:

> This article is most timely. In the almost universal drive to develop primary atomic and related sources of power, there must of necessity ensue a period when the use of fossil fuel sources must continue, so the depletion of irreplaceable natural resources must go on at an ever-increasing rate. Actually, the reduction of this rate of depletion is still some years away.
>
> The more efficient utilization of our existing energy sources has been greatly improved but when one realizes how even our best thermal establishments are below 40 per cent "coal pile to bus," the economic advantage with Pumped Storage of being able to obtain an over-all efficiency of 60 per cent plus, from afterbay to afterbay, is certainly a goal not to be ignored. In fact, it deserves exhaustive studies by every possible authority.
>
> We have for instance, except to a limited extent in the technical press, had little publicity given to the development of the Wisconsin River which has been termed "the hardest working river in the United States." And this has all been accomplished without financial aid from federal or public sources. Compared to the TVA activities, the Wisconsin River development is well worth keeping in mind as a truly typical example of unsubsidized approach.
>
> A positive advantage of Pumped Storage is the possibility of being able to use fully tested and developed equipment readily with no uncertain factors to be provided.
>
> It would be of interest to have information relative to the peaking service of various projects. Where operation is coördinated with thermal generation, kilowatt hours rather than kilowatts are a factor although peak loads for a hydro station reduce the head materially with attendant loss in kilowatt capacity.
>
> A method of approach which has received active attention in Great Britain has been the development of an air motor driven generator with air current developed in a chimney. This approach seems encouraging in view of the constant availability of an air current less subject to fluctuations due to weather conditions and dependence on a breeze, as is necessary with the windmill type of generating unit.
>
> While it seems almost too much to expect to have wind or air driven generating units supplying suitable motor driven pumps to keep the forebay level close to normal, it is a goal well worth while. And particularly as the power is independent of the main system operation. And the most valuable element is the possible nonuse of power from a thermal generating source.
>
> The table of definitions on page 105 is excellent and deserves commendation in view of the "loose" usage of the terms concerned when the meanings are not too well understood.
>
> Incidentally, there has been published information about a project in Italy where salt water is pumped to an elevated reservoir with power from a wind driven generator unit and is subsequently used by a water motor driven generator unit for power use.
> — *C. F. von Dannenberg*

MANY ENGINEERS have used our famous Power Plant Primer, written by Andy Kramer, as part of their instructional material in various power plant courses. Here is a recent typical example.

Michael Zulkoski, Instructor of the Mineral Industries Extension Services, The Pennsylvania State University, told us recently:

> Your booklet, entitled A Power Plant Primer, has been used as part of the reference material for an industrial coal salesmen's course on this campus. We are interested in obtaining 50 copies at this time.
>
> This course was inaugurated through the interest of the American Coal Sales Association in 1953. It is designed to give the participants basic knowledge of combustion of coal relative to the various methods of firing. Continued sponsorship of this course by the Association attests its value to the participants.

Those conducting the course obviously realize that in order to understand the importance of the combustion of coal, a knowledge of how it fits into the entire power plant picture is very desirable for coal salesmen.

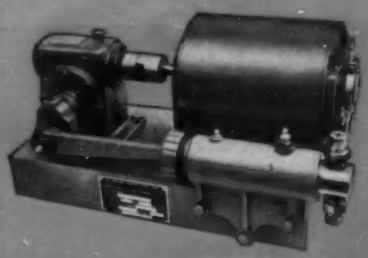
Of course we at once made arrangements to supply Mr. Zulkoski with the copies requested, and we are naturally quite pleased to have them used in this way.

FROM ENGLAND a reader wrote for the names of manufacturers of mobile steam generators. These were sent immediately, together with the following notes:

> Some installations of mobile steam generators have been made in highway trucks in this country, the units being mounted either on flat-bed trucks or trailers, depending primarily on the size. Portable units of the same design, but somewhat smaller, have been used to furnish heat in buildings under construction before the permanent boilers are completed — a steam hose connects the outdoor unit with the steam system inside the building.
>
> It is possible, of course, to bring in a "retired" steam locomotive for emergency steam supplies, but both emergencies and steam locomotives are becoming somewhat rare these days. An emergency which knocks out the steam generator stands a good chance of knocking out the load as well; hence, no need for an emergency unit. This is true because it usually takes a flood or something similar to cause shutdown.
>
> Much more attention is being given now to emergency electric power generation, which is being accomplished with mobile gas turbines and diesel units. A number of companies are becoming interested in this problem here, and several are watching with considerable attention.

"Boss, you know the solvent storage shed we had?"

pump or packaged unit



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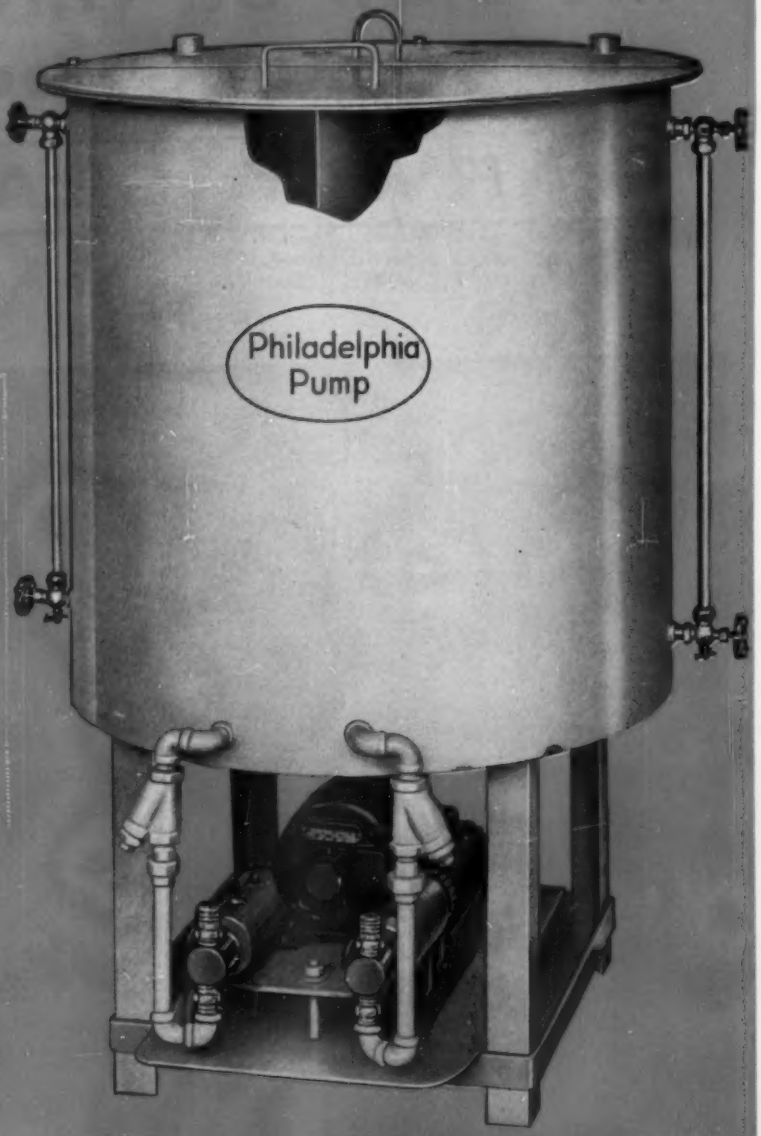
most dependable, low-cost means of feeding water-treating chemicals.

•

Made by the makers of the most complete line of controlled capacity chemical pumps.



• Self-contained chemical feed units comprise single or divided welded steel tanks, simplex or duplex PHILA-FEEDER pumps, gages, strainers and all necessary piping for proportioning chemicals into plant system.

PHILADELPHIA PUMPS

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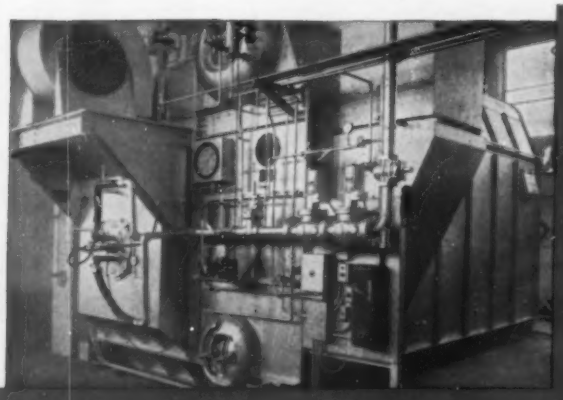
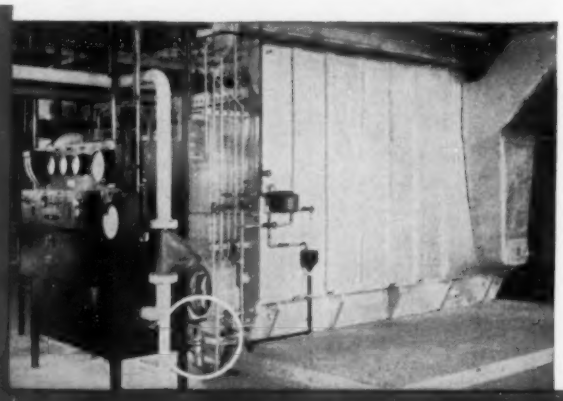
the blow-off valve trend on "package" boilers is

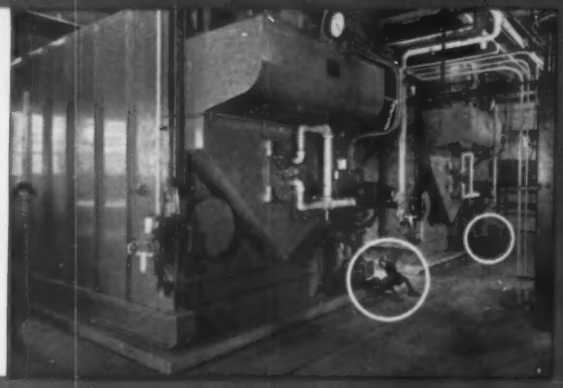
YARWAY SEATLESS



E. KEELER



COMBUSTION ENGINEERING



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YARWAY® **BLOW-OFF**

■ More and more leading manufacturers of package-type boilers are featuring Yarway Blow-Off Valves on their units. Many are standardizing on Yarways.

The reason—good blow-off valves help good package boilers *perform better*.

Yarway—known for nearly 50 years for *quality* blow-off valves—offers advanced design, dependable service, and reasonable cost . . . three features attractive to all boiler users.

The Yarway Seatless Blow-Off Valve, with balanced hollow sliding plunger and no seat to score, wear, clog or leak, is the most widely used valve for low and medium pressures.

Specify Yarway Seatless Blow-Off Valves on your package boilers. All boiler makers will supply them.

For full description of Yarway Seatless Blow-Off Valves write for Yarway Bulletin B-426.

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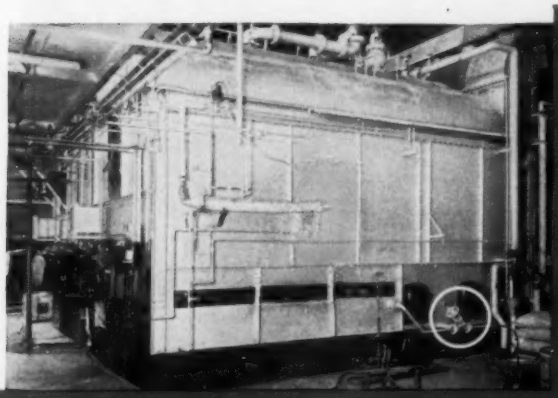
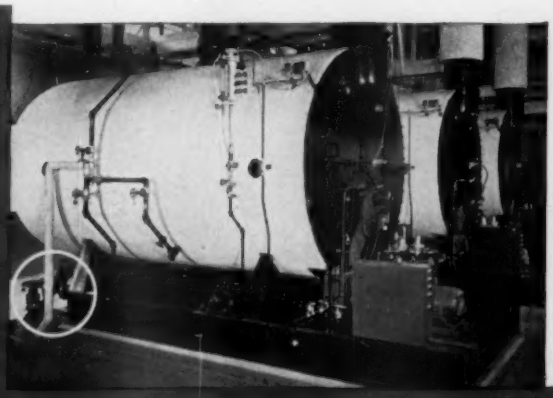
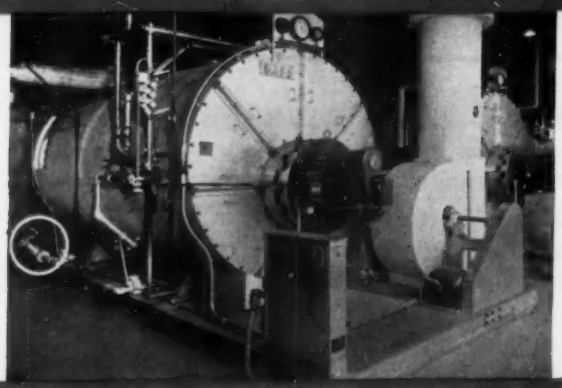
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



● ERIE CITY



● CLEAVER-BROOKS



● PREFERRED UTILITIES

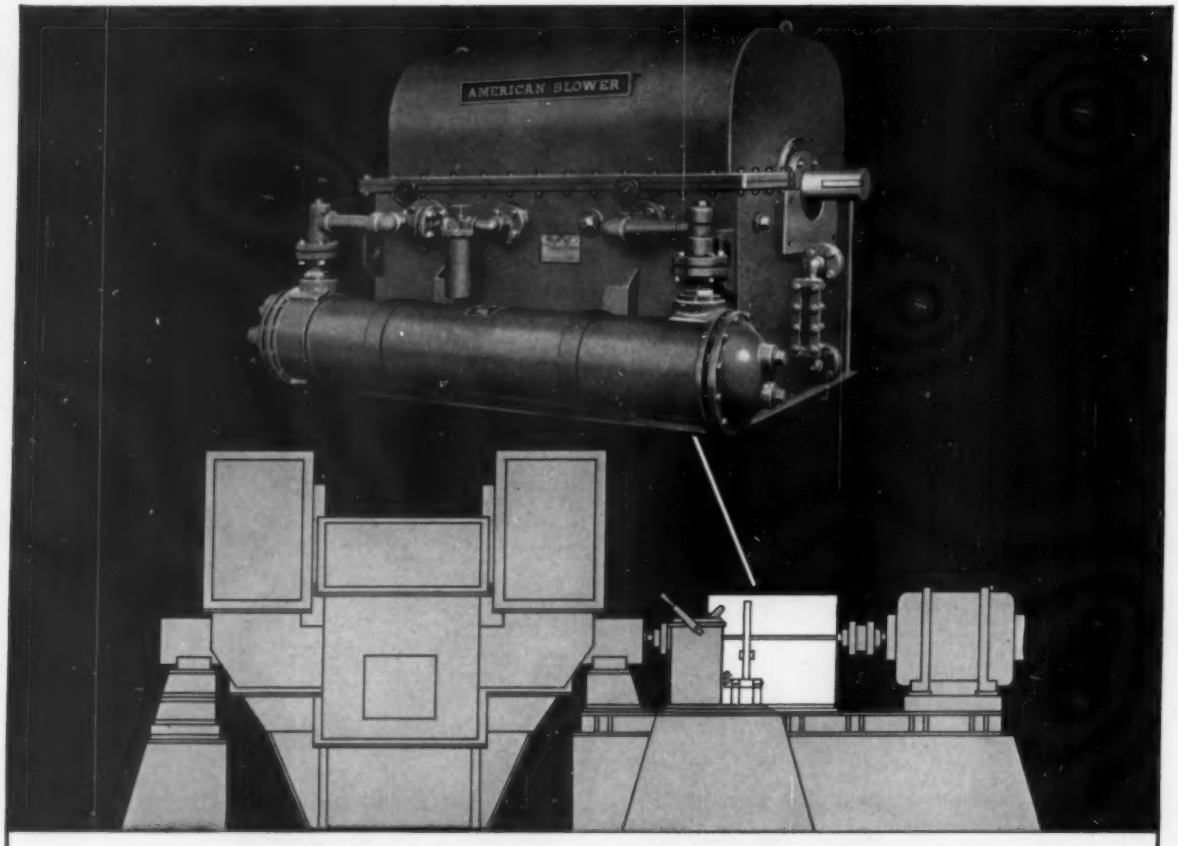
● **Yarway Seatless Tandem Blow-Off Valve** (angle-straightway combination) with angle valve sectioned to show balanced sliding plunger design.

● **Yarway Seatless Tandem Blow-Off Valve,** angle-angle combination, straightway-angle or straightway-straightway tandems also available.

VALVES

For more data circle 506 on Post Card

The tougher the duty, the more

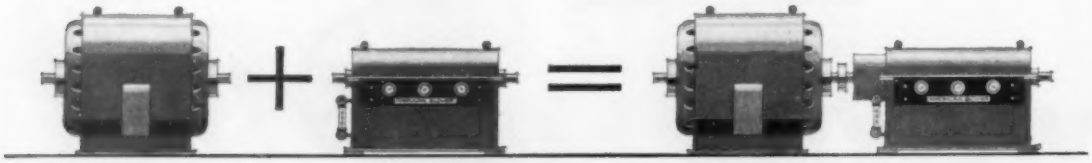


Mechanical Draft Fan Gýrol Fluid Drive Motor

LARGER MECHANICAL DRAFT FANS — Gýrol Fluid Drive gives you the kind of accurate, efficient control of mechanical draft that results in important power savings, longer equipment life. The reason: Fluid Drive's infinitely adjustable speed control, which enables each fan to operate at its optimum design or selection point.

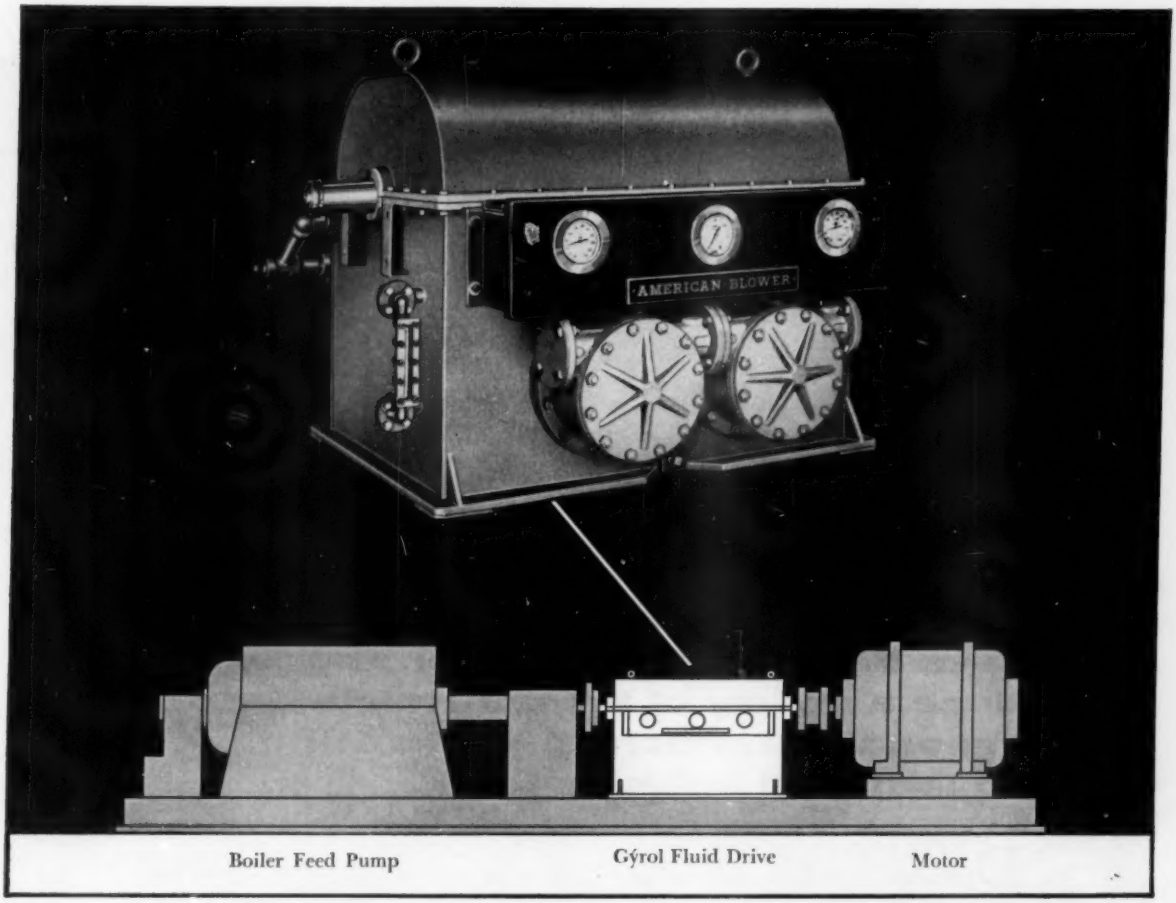
This adjustable-speed feature saves horsepower, gives good, stable volume and pressure control over the operating range . . . simplifies motor-starting equipment . . . reduces damaging high- and long-duration inrush currents on the motors . . . provides no-load starting of high WR^2s that exist in the new, high-volume, high-pressure fan wheels.

What's more, it prolongs life of fan bearings; reduces fly-ash abrasion on fan wheel, fan scroll, inlet boxes, and breeching connections. When you add to these advantages the reduction in noise level, it becomes increasingly clear that the tougher the duty, the more you need Gýrol Fluid Drive for control of mechanical draft.



Rugged constant-speed induction motor American Blower Gýrol Fluid Drive Smooth, adjustable-speed control

you need Gýrol® Fluid Drive



Boiler Feed Pump | Gýrol Fluid Drive | Motor

LARGER BOILER FEED PUMPS — As larger boiler feed pumps are built, there is a greater need for higher efficiencies and more accurate control. That's why more and more consulting and utility engineers are recommending Gýrol Fluid Drive.

You see, Gýrol Fluid Drive offers adjustable-speed pump control that saves power over the entire operating range by eliminating wasteful throttling. Then, too, Fluid Drive reduces wear on bearings and other vital parts by operating the pump at speeds that fit boiler demands. Paralleling of pumps is simplified. And emergency changeover from operating to standby pump is fast and foolproof—there's no need for boiler shutdown.

If your plant expansion calls for boiler feed pump control, it will pay you to talk to an American Blower engineer. He can show you where Gýrol Fluid Drive can save power, cut costs, give you a more efficient operation. Contact our nearest branch office, or write us direct. American Blower Corporation, Detroit 32, Michigan. In Canada: Canadian Sirocco Company, Ltd., Windsor, Ontario.

AMERICAN BLOWER

Division of American-Standard

For more data circle 507 on Post Card

ERIE CITY STEAM

CYANAMID

AMERICAN CYANAMID COMPANY

ORGANIC CHEMICALS DIVISION

BOUND BROOK · NEW JERSEY

The 650 Acre Fortier Plant of American Cyanamid on the Mississippi River near New Orleans, Louisiana

THIS $50,000,000 PLANT

Processes Natural Gas, Air, Water and Sulphur to produce a variety of Petrochemical Products, most important of which is Acrylonitrile, basic to farm and industry

Dependability is the keystone of petrochemical processing, and that is why we are proud to have Erie City steam generators selected for this important operation. Cyanamid's Fortier Plant gets its natural gas from the abundant Louisiana oil fields, its water from "ole man river" and its process steam from three Erie City 200,000 lbs./hr. steam generators.

Erie City has over forty years experience with 2-drum boilers gained in hundreds of installations. The basic 2-drum design, pioneered by Erie City, has been modified in a compact design to incorporate a completely water cooled furnace as an integral part of the main circulation system. Heavy refractory furnace linings are thus eliminated and continuously high ratings can be carried. Erie City 2-drum boilers permit wide flexibility, quick response to load changes and produce steam of high quality.

Erie City designs and manufactures all major components of its broad line of steam generators and offers undivided responsibility. For concise information about the complete line, ask for Bulletin SB-5033.

ERIE CITY

116 Years in Steam Generation

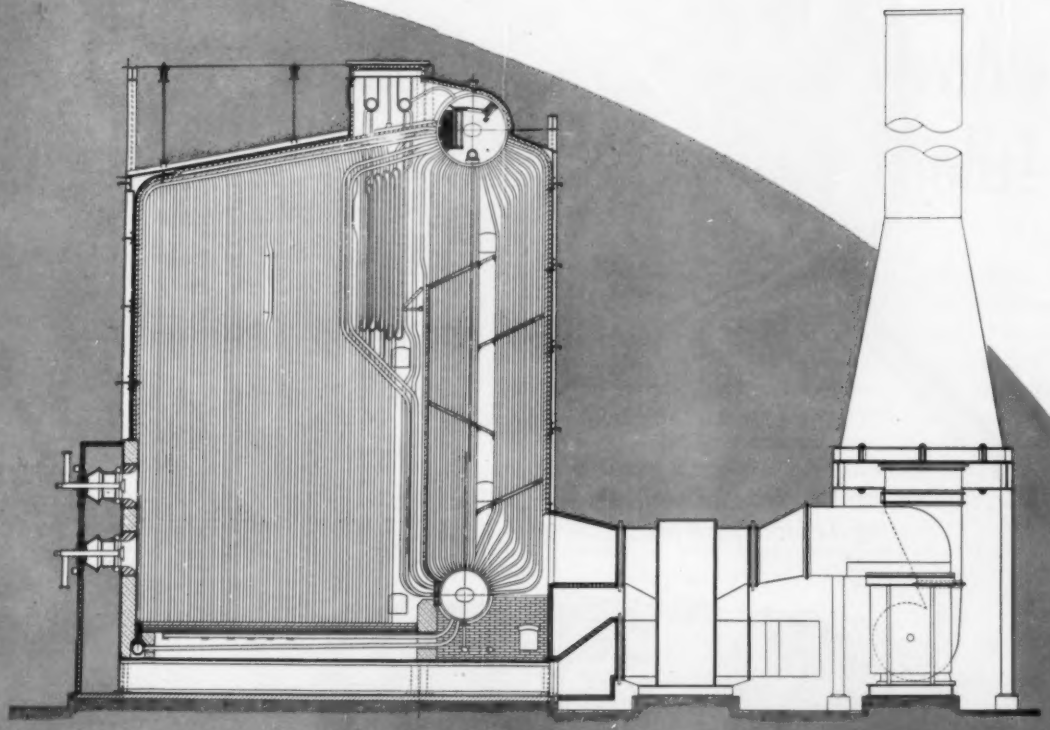
You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS

UNDERFEED AND SPREADER STOKERS • PULVERIZERS

- - - powers processing at FORTIER PLANT, New Orleans, La.



BOILER DATA:

BOILERS—2-DRUM

3 Erie City~

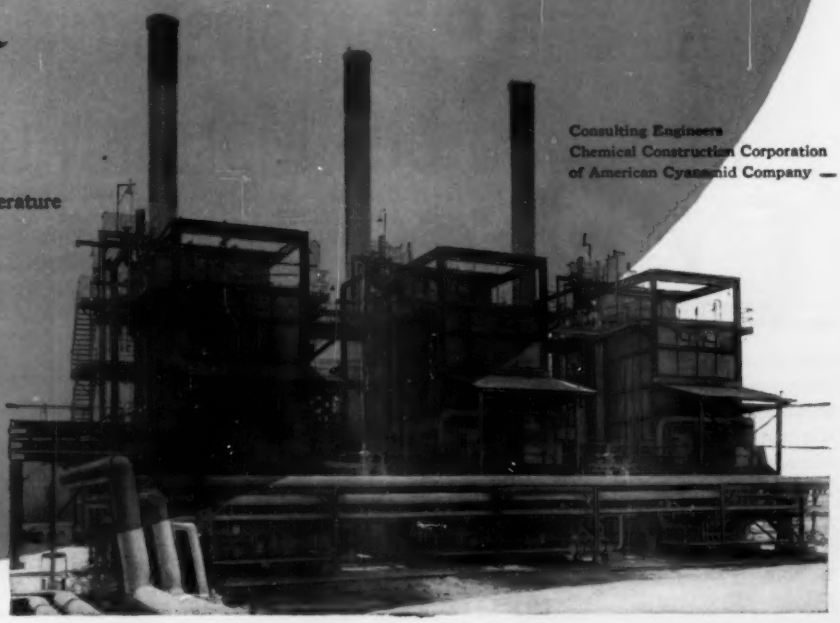
200,000 lbs./hr.

- Design Pressure
  700 psig
- Total Steam Temperature
  750° F.

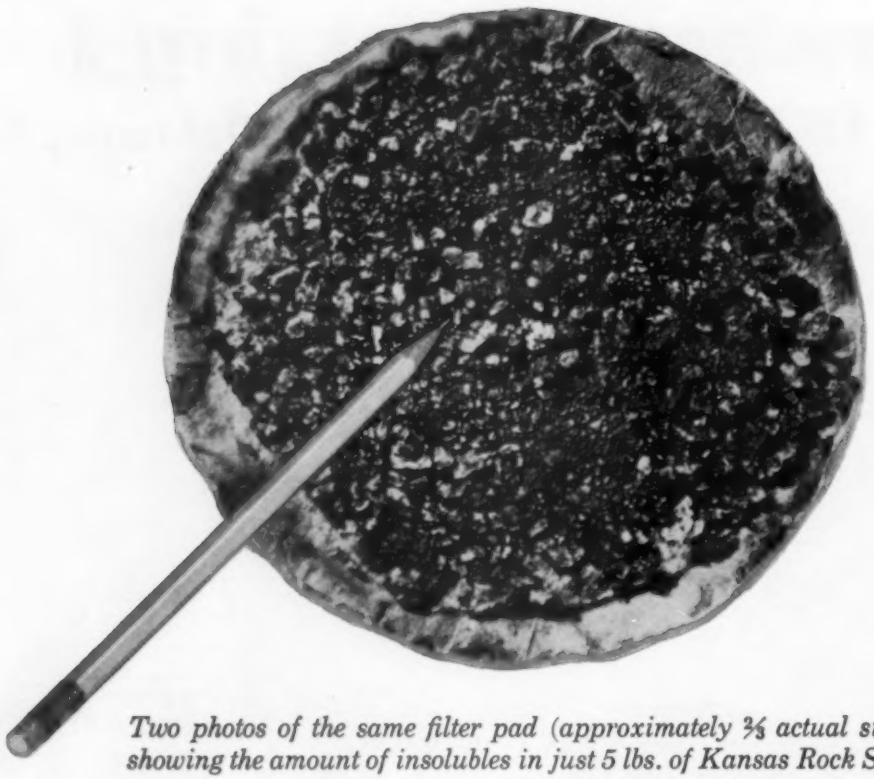
SUPERHEATERS—

E. C. PENDANT

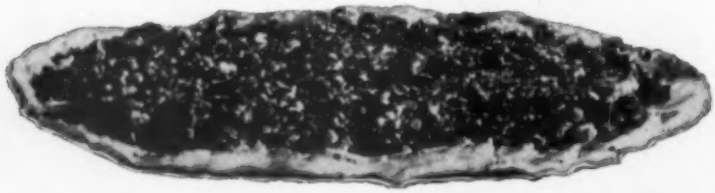
Consulting Engineers
Chemical Construction Corporation
of American Cyanamid Company —



For more data circle 508 on Post Card



Two photos of the same filter pad (approximately ⅗ actual size) showing the amount of insolubles in just 5 lbs. of Kansas Rock Salt



You don't pay for sludge like this when you buy Morton Purex Salt

When you buy Morton Purex Salt, you get high purity evaporated salt that is made in a controlled-particle size to prevent packing and channeling. None of your freight bill or purchase price goes toward paying for shale and sulphates . . . insolubles like those showing on the filter pad above. (And the cost can be considerable. In every 100 lbs. of any type of rock salt, you are paying for up to 5 lbs. of insolubles.)

With Purex, no time or labor is spent in cleaning out insoluble matter from your brine making system to keep it functioning at peak capacity. For Purex is 100% soluble. Morton Purex will leave no accumulation of material in either the brine or water softener tanks. It can be used in bulk wet-storage systems and in the Morton Model-E Brinemaker.

For more information about Morton Purex Salt or for free, expert help on any water softening or brine making problem, write or wire:

MORTON SALT COMPANY
INDUSTRIAL DIVISION
Dept. POE-8, 120 So. La Salle Street,
Chicago 3, Illinois

For more data circle 509 on Post Card

NOW

the right valves for more jobs!

Now you can apply high-quality Copes-Vulcan Valves to any application, at unlimited pressures in sizes up to 12 inches. Simplified design gives you this new versatility, plus high standards of performance for broader applications. Too, you will get the Copes-Vulcan custom-design, with ports exactly suited to the requirements of your operation.

Get in touch with your Copes-Vulcan man. He can help you apply the new Copes-Vulcan Valves to your control requirements. You'll get real dollars-and-cents savings in operational cost with less downtime in even those troublesome spots where ordinary valves are inadequate. Write for Bulletin 1027.

Piston-Type CV-P. For high-duty service. Extremely precise positioning gives you superb operating characteristics. Rangeability is high. Response can be characterized to meet your operating requirements. Designed for those applications which demand the ultimate in valve-operating force .... where you want the finest valve money can buy. Hand wheel is optional.

Diaphragm-Type CV-D. Either direct or reverse acting. High rangeability. Optional features include: Cooling fins and lubricator for stuffing box that will maintain low friction over longer packing life; hand wheel for emergency operation.

COPES-VULCAN DIVISION

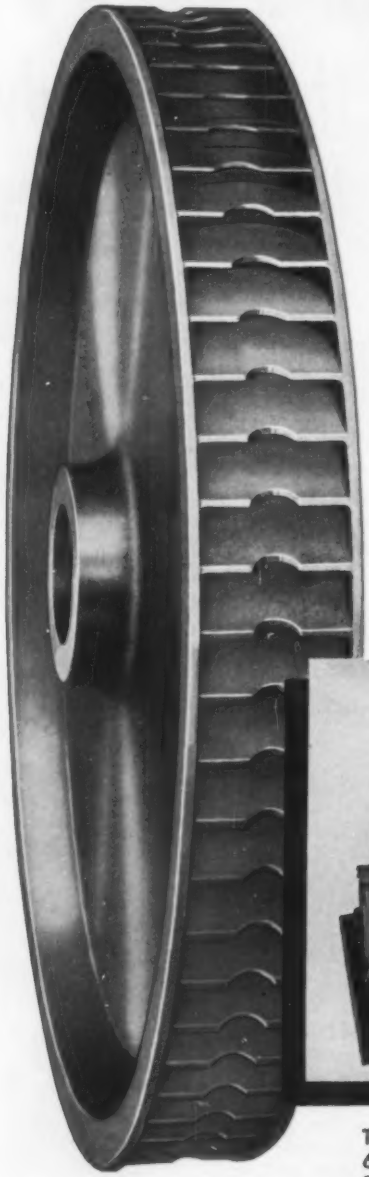
BLAW-KNOX COMPANY

ERIE 4, PENNSYLVANIA

50th Anniversary — BLAW-KNOX — 1906-1956

For more data circle 510 on Post Card

TERRY SOLID-WHEEL *SIMPLICITY* MEANS *SUSTAINED* HP



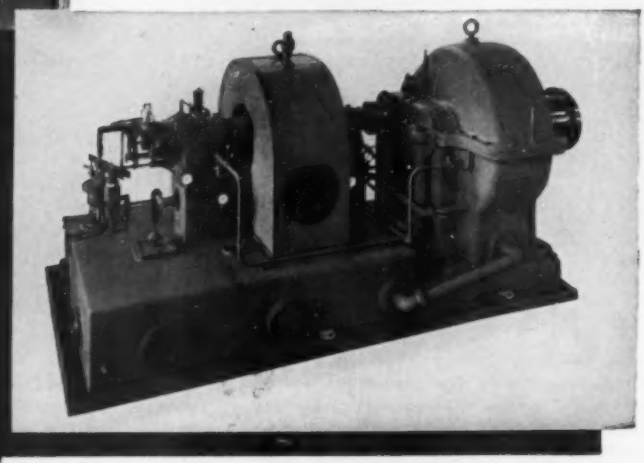
A Terry solid-wheel turbine is simplicity itself. Particularly the rotor. This is a single forging of special composition steel. And, unlike a built-up wheel, has no separate parts to loosen or work out.

Blade wear which might occur after years and years of usage is of little consequence, because the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets. Thus wear does not materially affect horsepower or efficiency.

The blades can't foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

Perhaps you, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives complete details. Send for a copy today.

TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONNECTICUT

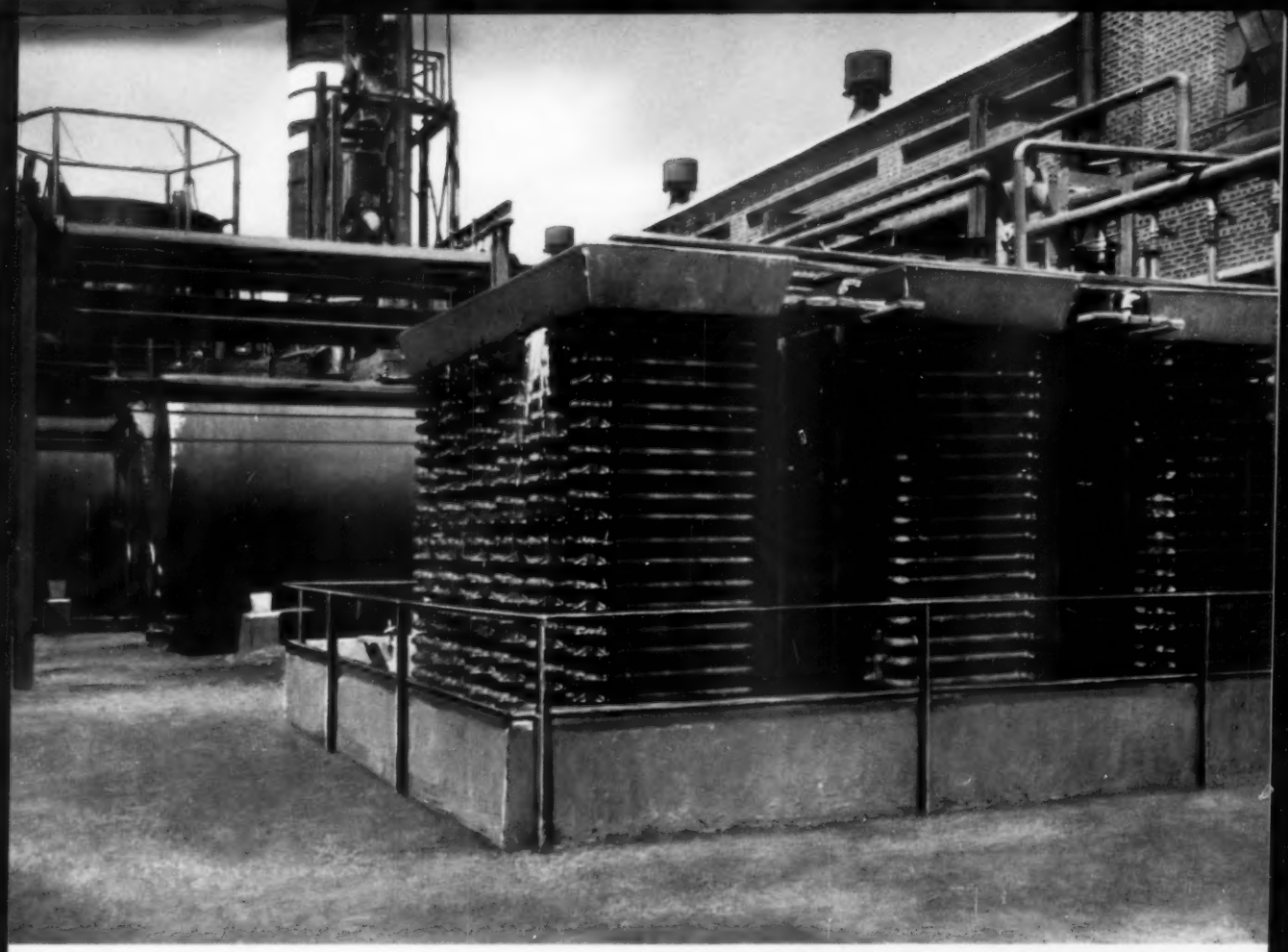


This Terry solid-wheel turbo-geared unit is rated 600 hp, 4000/650 rpm for 820 psi, 825°F steam with 275 psi back pressure.

TERRY

TT-1201

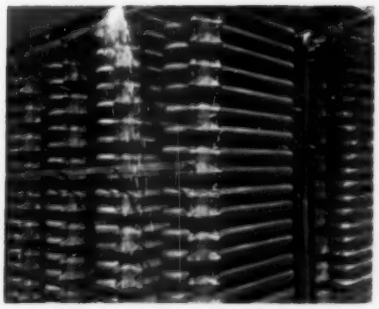
For more data circle 511 on Post Card



NALCO blue

that signals

CORROSION PREVENTION



Nalco blue on these exposed cooling unit coils is the visible evidence of effective corrosion prevention at work. Nalco System chemicals used in this installation form a tough protective film of characteristic blue color on all ferrous metal surfaces. The metal is literally sealed off from direct contact with water, air and fumes, yet the film itself will not impair heat transfer efficiency.

Similar Nalco protection for your plant can cut maintenance costs and protect you against unscheduled shutdowns that are frequently caused by damaging corrosion. Call your Nalco Representative for some facts and figures on Nalco System protection and economy.

NATIONAL ALUMINATE CORPORATION

6208 West 66th Place Chicago 38, Illinois

Telephone: POrtsmouth 7-7240

CANADA: Alchem Limited, Burlington, Ontario
NORTHWESTERN UNITED STATES, HAWAII AND ALASKA:
The Flax Company, Inc., Minneapolis 3, Minnesota
ITALY: Nalco Italiana, S.p.A.
WEST GERMANY: Deutsche Nalco-Chemie GmbH
SPAIN: Nalco Espanola, S.A.

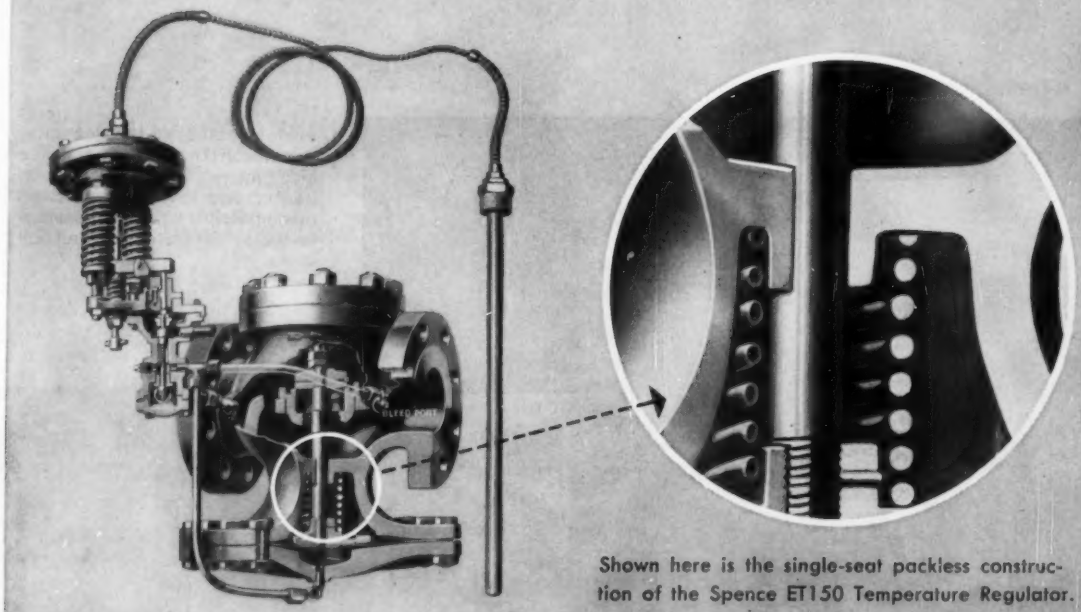
THE *Nalco*® SYSTEM . . . *Serving Industry through Practical Applied Science*

World's largest fleet of coal cars
62,000 coal cars, with 8,000 more on order, insure dependable deliveries from mines on the C&O
Chesapeake and Ohio Railway
WORLD'S LARGEST CARRIER OF BITUMINOUS COAL
For dependable deliveries of top quality coals, contact coal producers on the C&O. And if you need help in meeting your own particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

For more data circle 513 on Post Card

VALVE TIPS:

Advantages of Packless Construction in Temperature Regulating Valves



Shown here is the single-seat packless construction of the Spence ET150 Temperature Regulator.

One of the biggest headaches in regulating valve maintenance is repacking stuffing boxes.

How often a valve needs repacking, how much time it takes, and the cost of the system downtime all vary with the construction of the regulator and the service it's used for. No matter how you calculate all these variables it's still a headache—and an expensive one.

In the temperature regulator shown above (Spence Type ET150) stuffing boxes are eliminated. This is done by what is known as "balanced" diaphragm construction. You can see in the cutaway drawing that pressure is applied to both sides of the large metal diaphragm. The upper side is exposed to delivery steam pressure and the lower side is exposed to loading pressure applied by the pilot. When the pilot closes, both delivery pressure and loading pressure are equalized through the bleedport and connecting tubing.

This construction not only does away with repacking problems, but it makes possible additional savings as well. For example, you will note in the sectional blow-up that this design eliminates a closely fitted stem and guide. Dirt or other foreign matter doesn't have much of a chance to lodge between these parts and cause sticking.

Another cause of binding or sticking, uneven expansion of closely fitted parts, is also eliminated with this design. In addition, valve stem wear is reduced for the same reason.

Lower maintenance is not the only advantage of this packless construction. Accuracy of regulation is also improved because friction due to a stuffing box, dirt, or uneven expansion is not a problem. The large, *balanced* metal diaphragm is more sensitive to slight changes in pressure.

Guaranteed Not To Wiredraw

If seats and discs are cut by steam (wiredrawn) the loss of steam through these grooves can be another expensive item — directly charged against the regulating valve. Fortunately, you can eliminate these costly leaks by specifying a temperature regulator that is *guaranteed not to wiredraw.*

Spence makes such a guarantee because their seats and discs are made of SECO Metal. Over 20 years experience with this special alloy has failed to produce a single case where a SECO Metal seat or disc had been cut by steam. All that's required is an approved strainer located ahead of the regulating valve. Expensive steam leaks just can't happen with this combination of SECO Metal and single-seat design.

If you would like to have more information on Spence Temperature Regulators, drop us a line and ask for Bulletin T150. It gives more detailed information on these and other Spence design features. Piping layouts and helpful information on the installation of temperature regulators are also included. Write for your copy today.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

SE 140

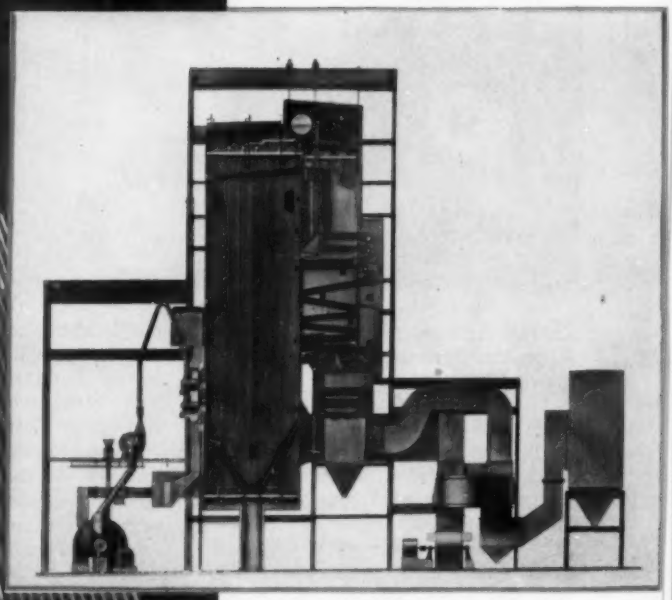
For more data circle 514 on Post Card

Second "outdoor type" FW steam

LOW LOAD FACTOR

installed at new

Prefabricated at the job site, panel construction of furnace side-waterwalls, radiant superheater and division waterwall made possible significant savings in steam generator construction costs.



Cross-section of Martins Creek No. 2 steam generator, designed for continuous rated capacity of 1,200,000 lbs/hr at 1325 psig normal, 955F. Divided furnace, combination radiant and convection superheater, two continuous loop economizers, weatherproofed outdoor type.

generator, designed for

and QUICK START-UP

Martins Creek Steam Electric Station

Built for "below zero" winter conditions, No. 2 unit raises capability of this modern steam generating plant of Pennsylvania Power & Light Company to 320,000 kw.

UNLIKE most new steam generators that are installed for base load operation, with peak loads being carried on older, less efficient units, the new No. 2 Foster Wheeler steam generator at Martins Creek is intended at the beginning to operate at only 20 to 40 per cent capacity.

Like the No. 1 FW steam generator at this station, it is a peak load unit. It has the requisite control facilities so that it quickly can help meet the early morning demand present in the PP&L system. For these heavy load periods, it provides the desired additional capacity economically, at minimum total annual cost — the major portion of the power being provided by other stations of the system where the delivered fuel cost is appreciably lower.

The eleventh FW unit now serving the Pennsylvania Power & Light Company, this Martins Creek steam generator has an 8-hour-peak capacity of 1,300,000 lbs/hr at 1325 psig, 955F at the superheater outlet. Final steam temperature is held constant at all loads from 325,000 lb per hr to full load. Of the single drum, nonreheat type, it supplies steam to a turbine generator with a nameplate rating of 132,500 kw. Two Foster Wheeler ball mill pulverizers furnish bituminous coal to twelve 30-inch FW intervane burners.

View looking south showing Pennsylvania Power & Light Company's new Martins Creek Steam Electric Station.

Backed by more than 50 years' experience in power plant equipment pioneering, steam generators by Foster Wheeler assure efficient, dependable performance at low overall cost. Whatever your requirements, it will pay you to consult us. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

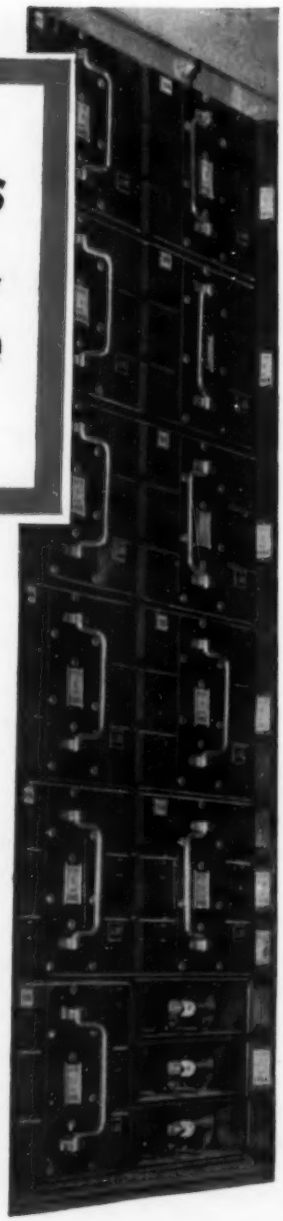
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data circle 515 on Post Card

. . . "After these two experiences with FUSETRON dual-element Fuses, we use them throughout our Entire Plant."

J. W. Sanders, CHIEF ELECTRICIAN
(Division of Simmons Co.) ROSEMARY MFG. CO.
ROANOKE RAPIDS, N. C.



"SOLENOIDS WERE BURNING UP AND STARTING *FIRES — Until we changed to FUSETRON FUSES.*"

"A fire in our weaving room is just about the gravest danger we can face. If the fire isn't checked immediately, it can quickly spread throughout the room.

"You can imagine then how concerned we were with fires started by solenoids burning up in heavy lint locations. With 500 looms in use in 3 weaving rooms, we didn't know where to expect the next fire.

1

"We definitely had to find safer solenoid protection than we were getting from one-time ordinary fuses in use. We decided to try Fusetron dual-element fuses and installed them in the summer of 1954.

"It was a big relief when Fusetron fuses turned out to be the answer. I'll knock on wood, but we haven't had a fire since we installed them.

"In addition, this move to Fusetron fuses also cut production costs. We eliminated needless down-periods and we no longer have to repair or replace burned-out solenoids."

"WE CUT UNNECESSARY DOWN-TIME AND MAINTENANCE *COSTS By installing FUSETRON FUSES.*"

"Several years ago we had a heating problem in our main panels that was causing ordinary renewable fuses to blow.

"These outages occurred several times weekly in each panel, so down-time costs were really adding up and costing our company money.

"Also, after each blow our maintenance men would spend time checking the circuit for trouble, only to find the outage was caused by excessive heating in the panel.

2

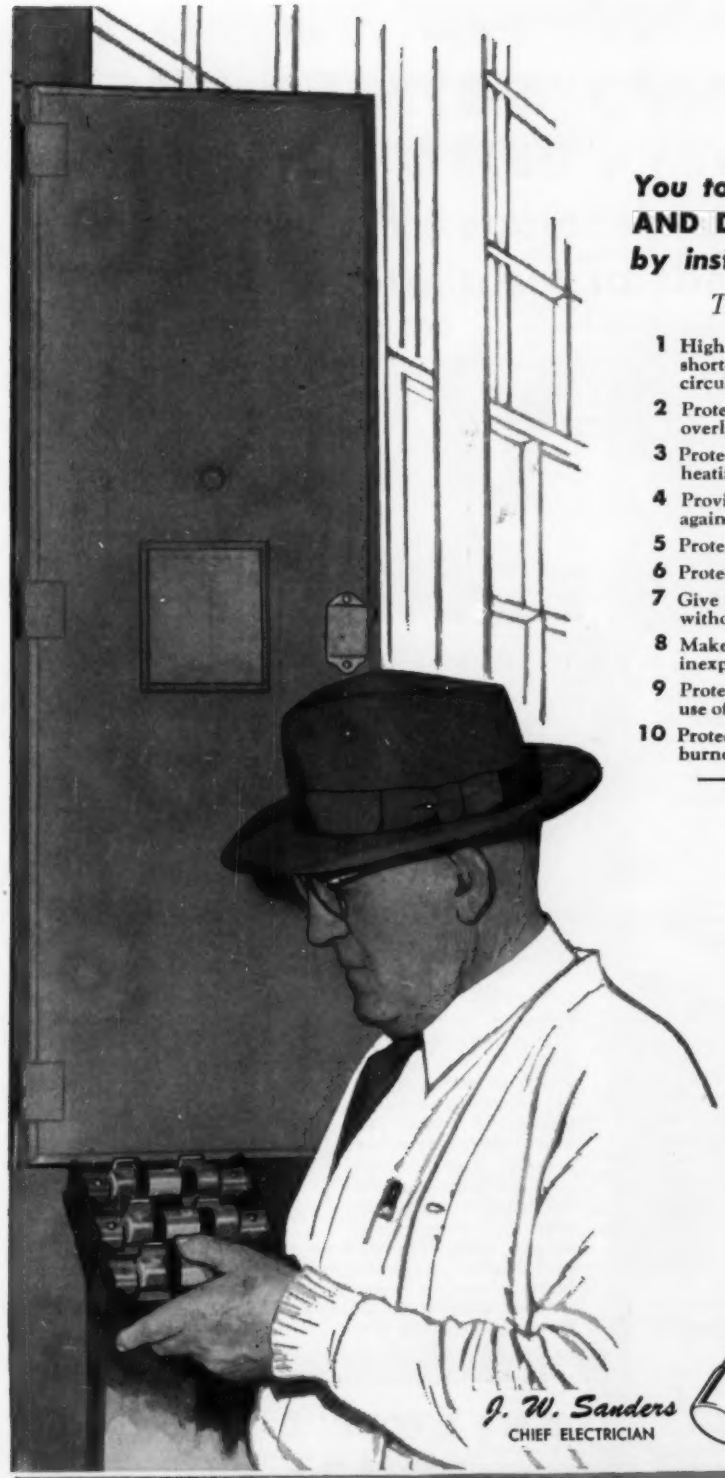
"We discussed the situation with a salesman and he showed us that Fusetron dual-element fuses were cooler operating and would eliminate our trouble.

"They sure did! The change to Fusetron fuses of proper size for safe protection was completed in 1953. We haven't had any unnecessary shut-downs since then.

"Our maintenance men sure like the change. Any outage today indicates trouble, and the men know they are not wasting time when they check the circuit.

"Because of this and other satisfactory experiences with Fusetron fuses, we individually protect all our motors with them as well as using them throughout the rest of the electrical system.

"I wish we had kept a record to show how much money we saved by equipping each motor with Fusetron fuses. I am reasonably certain that the difference in motor burnouts alone would represent considerable money."



You too, CAN REDUCE FIRE HAZARDS AND DOWN-PERIODS *by installing FUSETRON FUSES!*

They provide 10 Point Protection

1 High interrupting capacity—protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating—lesser resistance results in cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloads.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS., *Use BUSS Hi-Cap Fuses . . .*

They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

J. W. Sanders
CHIEF ELECTRICIAN

Play Safe! Install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO. *Div. McGraw Electric Co.*
University at Jefferson St. Louis 7, Mo.

758

For more data circle 516 on Post Card

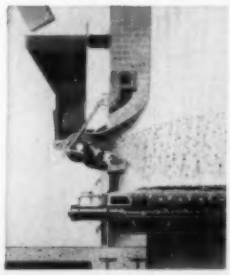
CHOOSE STOKER FIRING FOR ECONOMY AND SATISFACTION

Coal, Burned With a DETROIT STOKER Offers Many Advantages, Proven By Thousands of Installations

- Assured Fuel Supply
- Provides Steam At Lowest Cost
- Dependable—Noted For High Availability
- Maintenance Expense Low
- Requires Little Power For Operation

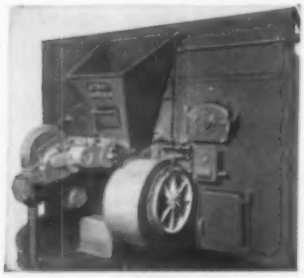
One of these Detroit Underfeed or Spreader Stokers will save you money—they are backed by over a half century of experience.

DETROIT ROTOSTOKER



Spreader stoker with OVER-THROW ROTORS that distribute the fuel uniformly in the furnace. Fine particles burned in suspension and coarse coal, burned on the grate. Four types of grates are available. Roto-Stokers burn successfully an extremely wide range of fuels without any special preparation. In combination with coal, RotoStokers also successfully burn wood and other refuse.

DETROIT UNISTOKER



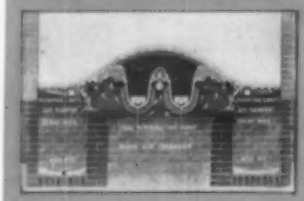
Plunger feed, side-cleaning stoker is available in various sizes for 125 to 250 horsepower boilers. Full-housed blower either motor or steam turbine driven, mounted at stoker front. Adjustable Feed provides for either manual or automatic coal feed control.

DETROIT ROTOSTOKER TYPE C-C

(Continuous Cleaning)

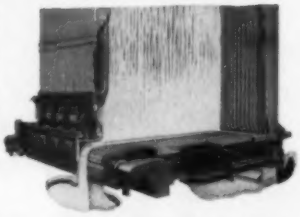
An important addition to the comprehensive "Detroit" line of spreader stokers. Readily applied to small and medium size steam generators approximately 5,000 to 75,000 pounds of steam per hour. The continuous cleaning grates automatically discharge the ash at the front for easy removal. No basement needed.

DETROIT DOUBLE RETORT STOKER



A multiple retort stoker having two retorts, with the side-cleaning feature requiring no basement. Now available with Detroit Adjustable Feed Coal Feed Control. For medium sized boilers.

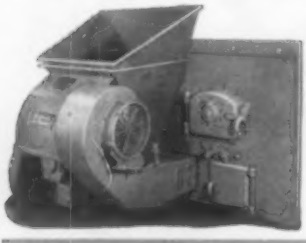
DETROIT ROTOGRATE STOKER



Spreader stoker with FORWARD MOVING GRATES for medium and large boilers up to approximately 400,000 pounds of steam per hour. Screenings or crushed run-of-mine coal used without grinding or pulverizing. Successfully burns a wide range of fuels, including lower grades of Bituminous Coal and Lignites . . . with preheated air if desired. Higher burning rates for longer periods with low excess air and without slagging or clinkering difficulties. Combustible in ash is unusually low.

DETROIT LOSTOKER

Has Detroit Adjustable Feed (Coal Feed Control).



A complete firing unit. Compact—single retort—mechanically driven—plunger feed—side-cleaning design. Many sizes and capacities for various types of boilers. Simple, accessible, dependable. A great coal saver.

DETROIT STOKER COMPANY

GENERAL MOTORS BLDG., DETROIT 2, MICH.

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INVESTIGATE DETROIT STOKERS — IT'S THE ROAD TO ECONOMY AND SATISFACTION

For more data circle 517 on Post Card

HELPFUL BULLETINS

INSTRUMENTS AND CONTROLS

101 Test Instrument Guide — Instruments for testing and calibrating current actuated protective devices are described in 68-pp Catalog 3561. Covers standard and special equipment for safety testing protective relays, oil circuit reclosers and related devices, and contains product descriptions, application recommendations, illustrations, schematic diagrams and technical data. Catalog also provides a recapitulation of relay testing practice today, with recommendations on rapid and safe new techniques to inspect critical protective equipment on installation and afterward. Multi-Amp Corp.

102 Temperature Controls — This 8-pp condensed catalog contains model illustrations and brief descriptions of temperature controls and allied equipment for industrial heating and refrigeration. These are applications rangingfrom —30 to 1200 F. Included are recording, indicating, nonindicating controls; thermometers, bulb installation accessories, process timers, gas pilots. The Partlow Corp.

103 Fault Locator — This 12-pp booklet describes the Brunt Faultfinder — a combination ground detector and fault locator used to detect and locate accidental grounds on normally ungrounded electrical power circuits of up to 600-v a-c or d-c while these circuits are energized. Covers such aspects as interpretation of signal and determination of fault, lists applications and includes service instructions and specifications. Parr Mfg. Corp.

104 Versatile Instrument — Six-pp Bulletin 301 discusses applications for, and features of, manufacturer's Transometer which comprises a positive displacement type flow meter with a pneumatic signal transmitter. Shows how the device is used for flow, ratio and combustion control; for multiple fuel totalization, and for interchangeable control in fuel switchover. Lists viscous and other liquids this instrument will handle. Ranges, specifications and performance features are also given. Askania Regulator Co.

105 Smoke Density Indicator — Details of company's Fireye FE-3 smoke density indicator system are presented in Bulletin CM-22. Illustrated with photos and drawings, the bulletin gives operating and specification data. Installation information is provided in schematic drawings. Three smoke recorders for use with the system are described. Combustion Control Div., Electronics Corp. of America.

106 Armored Rotameters — Twelve-pp Bulletin 130 contains photos and cutaway drawings of company's armored rotameters and also describes all types of indicating and transmitting extensions available. Includes details of design and construction, capacity charts and principles of operation. Brooks Rotameter Co.

107 Leak Detector — Bulletin GEC-233F, 8 pp, describes features, specifications, and operation of a portable instrument for locating leaks in closed systems. Applications in various industries are also described. General Electric Co.

108 Thermocouple Data — Bulletin F-5228-3, 40 pp, discusses construction and use of thermocouples and radiation detectors in industrial control applications. Included is information on how to check, make, and select and size thermocouples. Standard thermocouple temperature-millivolt equivalents with temperatures being expressed on the International Temperature Scale of 1948 are also included. Electromotive force is expressed in absolute units. Wheelco Instruments Div., Barber-Colman Co.

MECHANICAL POWER TRANSMISSION

109 Fluid Drives — Bulletin 9919 covers application of company's fluid drives in the petroleum industry and describes their advantages as applied to pipe-line compressor stations, refineries and other petroleum industry applications. A cross-section drawing and flow diagram show operation. American Blower Corp.

110 Worm Gear Drive — Advantages of company's worm gear drives are outlined in illustrated Form 521. Typical applications are described and various types of units are pictured. The Cleveland Worm and Gear Co.

111 Power Transmission Equipment — Form 1200, 12 pp, features flexible couplings, variable speed pulleys and transmissions, and universal joints and motor bases. Information includes operating data, horsepower ratings, sizes and types for countless applications and widely varying working conditions. Lovejoy Flexible Coupling Co.

112 V-S Transmission — How to provide simple, direct, low cost speed adjustment for all machines using V-belts is told in this 12-pp bulletin. Describes operation of company's variable speed transmissions, and includes dimension charts, drive data, application chart, selection formula. Maurey Mfg. Corp.

113 Power Take-Offs — Bulletin 308 8 pp, provides horsepower and torque capacities, side pull limitations, and dimensions for all of company's friction power take-offs, including the S P line for high-speed, high-output industrial engines. This line ranges from 95 to 602 hp in capacity. Twin Disc Clutch Co.

114 Internally Geared Power — Featuring latest design improvements in gearmotors and embodying 60 multicolor illustrations, 16-pp Form F-1880 shows comparative advantages of gearmotors, lists ratings from ½ to 30 hp with gear ratios as high as 10:1. Cross-sectional details and enlargements of outstanding features are included, as well as a discussion of use of elliptoidal helical gears, and a chart graphing degrees of tempering of gear teeth. U. S. Electrical Motors Inc.

115 High-Speed Reduction Gears — Descriptive Bulletin DB 1165 describes high-speed reduction gears for mechanical-drive steam turbines having capacities from 50 to 5000 hp. Illustrated bulletin describes various parts of gear assembly, lists dimensional and weight specifications, and includes drawings of assembly. Westinghouse Electric Corp.

116 Variable, Combination Pulley — Catalog 60A, 18 pp, illustrates and describes company's variable pulleys and combination pulleys, including accessories. Rating and dimension tables are designed to facilitate selections. Lewellen Mfg. Co.

117 Precision Roller Bearings — Data on sizes, capacities, and mounting details for precision roller bearings is contained in Bulletin H-54A, 58 pp. Items covered are company's Series SR and SE Multirol bearings; Series CF, SCF, and CYR Camrol bearings; and Series MT, SG and CT Guiderol bearings. Also described are band-saw guide wheels. Seal combinations available are also covered. Dimensions, load capacities, and recommended uses for these bearings are listed in detail. A special feature of this handbook is a chart listing stock numbers of interchangeable bearings of various manufacturers. McGill Mfg. Co., Inc.

HEATING, COOLING

118 Gas Heating Equipment — Comprehensive Catalog GN-56, 24 pp, presents suspended gas unit heaters, both fan and blower types, in capacities from 25,000 to 250,000 Btu; a deluxe suspended unit heater; a floor model; duct furnaces; and a horizontal furnace. In addition to specifications, construction details and dimensions drawings and tables, catalog also provides installation information and application ideas. Reznor Mfg. Co.

119 On Unit Heaters — Latest improvements, specifications and performance data for Herman Nelson horizontal and vertical unit heaters are covered in 36-pp Bulletin 700A. Includes complete hot water and steam performance tables, dimensions, selections, applications, descriptions of cabinets, elements, motor mountings, fans and accessories, controls. Also provided are suggested layouts, piping diagrams, other technical data. American Air Filter Co., Inc.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 121 and 122

120 Heating Cable — Ten-pp Bulletin 19-675 contains product, application, installation information, and collateral data to help in selection of heating cable for any specific job. Three types are discussed: silicone rubber-insulated with lead jacket; asbestos-insulated with lead jacket; and silicone rubber-insulated with rubber jacket. Typical applications, installation diagrams and conversion tables included. General Electric Co.

121 Heating, Cooling Coils — This 36-pp catalog covers company's standard line of Tru-Air heating and cooling coils, illustrating helical fin construction and

fabrication methods. Capacity tables and selection graphs are included, along with data on selection of water, heating and cooling coils, standard and non-freeze steam coils. M. Blazer & Son.

122 Heat Exchangers — Eighteen-pp Bulletin M-306 on heat exchangers for process industries, includes design applications and construction details of these standard units. Provides tables of effective surface area available in the various units; tables of overall dimensions; and thermal design data, with tables of film coefficients, pressure drops, fouling factors, and tube characteristics necessary to solve basic heat transfer equations. The Lummus Co.

BOILERS, GENERATORS

123 Steam Generators — Two engineering bulletins cover company's Type A and Type S water tube steam generators. Bulletin 55-2 describes the former, and Bulletin 56-1, the Type A shop-assembled boilers. Both bulletins include descriptive text, photos and separate data sheets of engineering drawings and technical information. Drawings included offer dimensions of external and internal construction features, as well as complete boiler data — furnace volume with different fuels, boiler heating surface, and number of tubes. Wickes Boiler Co.

124 Wet Back Boilers — Catalog AP-294, 8 pp, features 13 sizes of company's 800 Series Wet Back Scotch type boilers, specifically designed for use with forced draft oil, gas, or combination gas-oil burners. Describes "wet back" insulating feature, lists ratings, capacities, recommended burner sizes, dimensions and engineering data. Cutaway view shows component parts. Pacific Steel Boiler Div.

PUMPS, PUMPING

125 Process Pumps — Circular 184, 12 pp, features standard centrifugal process pumps for industrial, refinery and general service. Advantages of design with interchangeable parts are outlined, and pump sizes, head-capacity range charts, and sectional views and parts lists are furnished. Dean Brothers Pumps Inc.

126 Submersible Pumps — Bulletin P55-123, 12 pp, describes advantages of company's submersibles and tells how they solve various pumping problems. Design features are illustrated through cutaway views and motors specifications and capacity in gallons per minute are shown. Byron Jackson.

127 Canned Motor Pump — Bulletin 1060 describes and illustrates company's Series E low-cost, compact canned motor pump less than 8-in. long — a mere "bump in the pipeline." Complete details on performance, NPSH requirements, materials of construction, power inputs, temperature and pressure limitations, dimensions and other data are given. Chempump Corp.

128 For Ash Handling — Twelve-pp Data Sheet Pa contains general description and engineering data on company's Hydroseal pumps for hydraulic ash handling systems. Photos, schematics and line drawings illustrate design, construction and operation of these abrasion resistant centrifugal pumps. Tables give capacities and related data, including friction loss in pipe and fittings. The Allen-Sherman-Hoff Co.

> You'll save time in ordering bulletins by using the Reader Service Cards on page 121. Of course we honor letterhead requests—but it takes us somewhat longer to handle them.

PACKING, SEALS

129 Valve Stem Packing — Form 6901 describes two general types in which valve stem packings are available (braided of asbestos yarns, and plastic), the manner in which they are made and illustrates shapes most commonly used, as well as listing size limitations. It also provides a recommendation chart for standard items used against various fluids, gases. Packing Div., Raybestos-Manhattan, Inc.

130 Stuffing Box Seal — Circular 189 details a practical, economical solution to mechanical stuffing box sealing in company's standard centrifugal pumps for high temperature service. Describes single inside mechanical seal and includes operation data. Dean Brothers Pumps Inc.

PIPING AND VALVES

131 Wrought Iron Pipe — This 16-pp booklet discusses wrought iron pipe for modern buildings. Identifies wrought iron pipe and describes composition and advantages. Included are sections on wrought iron's resistance to corrosion and fatigue stresses, weldability, forming and threading as well as the application of protective coatings to the material. Pictures and sketches show uses. A. M. Byers Co.

132 For Process Industry — Bulletin TB-410, 8 pp, deals with use of seamless and welded stainless steel pipe and welding fittings in the process industry where corrosion and/or elevated temperatures are determining factors. Contains application data on widely used stainless steels and furnishes helpful hints on the bending, joining and welding. Tubular Products Div., The Babcock & Wilcox Co.

133 Stainless Tubing, Pipe — Bulletin TB-355A outlines advantages of stainless tubing and pipe, such as resistance to corrosion, contamination, pressure, temperature, abrasion, and wear. Properties of stainless steels for tubing and pipe are tabulated. Tubular Products Div., The Babcock & Wilcox Co.

134 PVC Pipe and Fittings — Bulletin 51155, 12 pp, describes company's corrosion-resistant polyethylene and polyvinyl chloride pipe, tubing, ducting, valves and fittings for industrial applications. Information includes a summary of pipe materials; fabricated pipe fittings data; details on larger dimensions of cast pipe; properties of company's pipe; list of literature available. American Agile Corp.

135 PVC Pipe, Valves, Fittings — This 8-pp memorandum features engineering data on polyvinyl chloride pipe, valves and fittings. Covers in detail the corrosion resistance, general properties, fabricating characteristics and economies of unplasticized PVC. Peter A. Frasse and Co., Inc.

136 Valves for Tough Jobs — Design and operating principles of company's manual and automatic valves especially designed for tough jobs are featured in this 20-pp bulletin. Performance and engineering data, material specifications, and cutaway views of various types of valves are included. P-K Industries, Inc.

ELECTRIC GENERATORS

137 Turbine Generator — Bulletin 1960-C, 35 pp, features turbine generators in the 1500 to 15000 kw range, and includes information on types and applications, construction, testing and lubrication, sole plates, design features, and lagging. Cutaway view of typical multi-stage condensing turbine and one of an alternating current generator are included, as well as installation photos. Worthington Corp.

138 Generating Plants — Form A428-356, 8 pp, describes company's complete line of electric generating plants, including one-cylinder air-cooled, two-cylinder air-cooled, four-, six- and eight-cylinder water-cooled models and air-cooled diesel models. A detailed model selection guide, giving model number, description, starting method, type of engine and dimensions and weights of each plant is included. D. W. Onan & Sons Inc.

WATER TREATMENT

139 Pressure-Type Filters — Twelve-pp Bulletin WC-107A describes the uses, design features and engineering details of pressure sand and gravel filters. Details of accessory equipment, the different types of controls available and a detailed table giving capacities, sizes, and space requirements are included. Cutaway views of horizontal and vertical filters are shown as well as details of strainers, distributor systems and piping arrangements. Graver Water Conditioning Co.

140 On Algae Control — A simple, low cost way to stop algae problems in cooling systems through use of company's 120 Series algaecide is described in Bulletin 28X8434. This algaecide is a complex organic rosin base liquid described as simple to apply and safe to use. A table shows its effectiveness on six species of algae. Allis-Chalmers Mfg. Co.

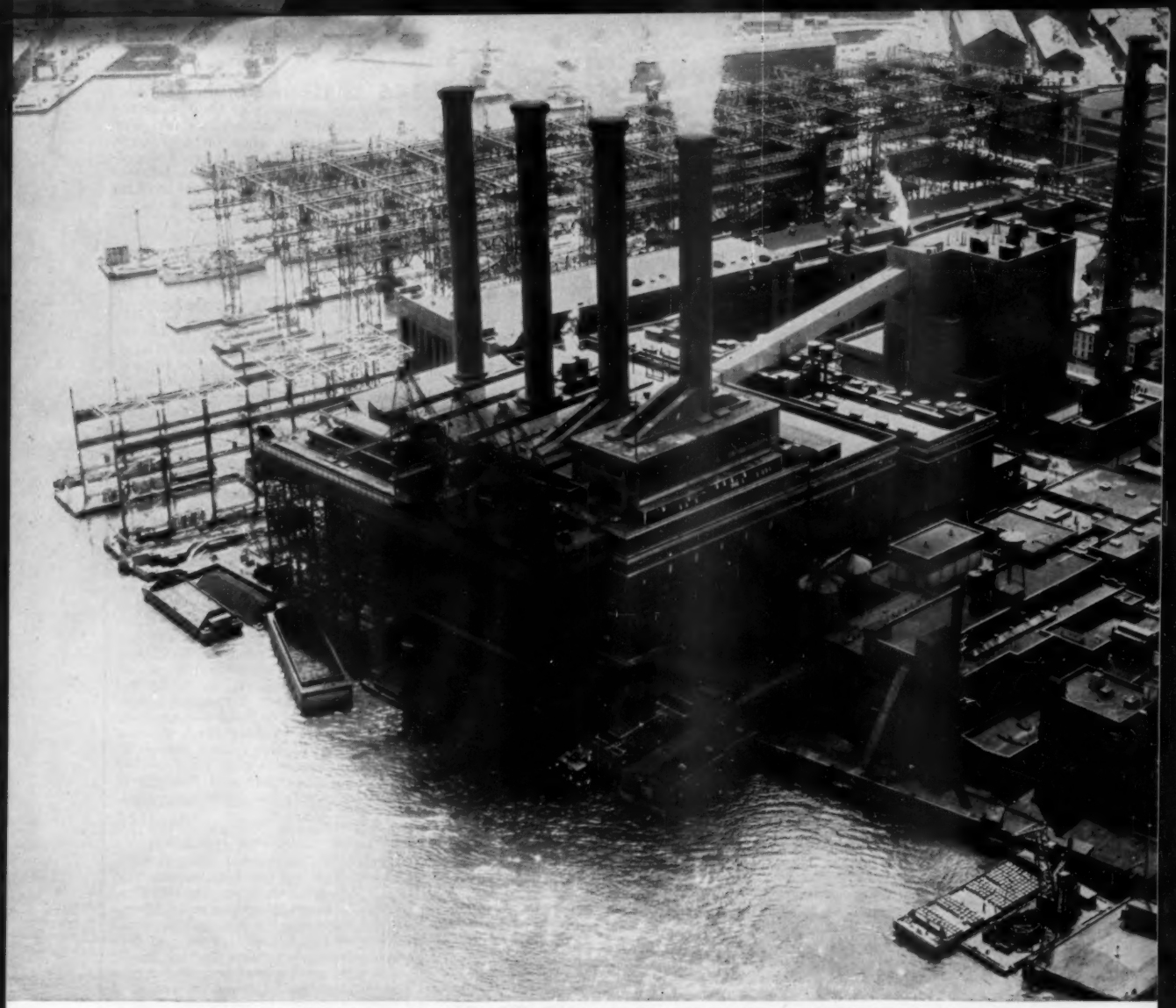
141 Deaeration — Why? How? — Publication 4650 explains in capsule form the fundamentals of deaeration and why it is so necessary in water conditioning. Principles of operation as well as advantages and application of various methods are discussed. Cochrane Corp.

142 Evaporator — Operation and design details on an improved evaporator designed for rugged and efficient service are presented in this illustrated booklet. Cutaway view shows important features of the unit. Alco Products, Inc.

LUBRICATION

143 Lubrication System — Bulletin 1450 contains design and operation information on company's lubrication coolant systems, with pictures of typical installations and a diagram of a mill lubrication system. Also describes a compact, packaged lubrication system in capacities to 50 gpm. Dravo Corp.

144 To Rout Sludge — How to clean sludge out of hydraulic and lubrication systems without shutting down machines is told in Technical Bulletin 44. It discusses use of detergent oils in keeping equipment clean. Sun Oil Co.



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IT'S NOT WORTH THE CHANCE —CLEAN IT RIGHT

Equipment that operates at less than peak efficiency eats into your company profits. Chemical cleaning can help stop these losses—but only when it's done by experts. Unless you rely on experts, you're taking a chance with your men and valuable equipment.

Dowell engineers understand your cleaning problems and they have the *experience* needed to solve them. Thoroughly trained, they're backed by Dowell's 15 years' experience in removing troublesome scale deposits from virtually every kind of equipment in every kind of industry. They're aided, too, by a completely modern, fully staffed and excellently equipped *research* laboratory.

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The greatest customer-acceptance in Titusville's many years of Scotch Marine boiler manufacture requires shipments by the trainload to satisfy! The reason is an ever-wider appreciation of Titusville as a BETTER BOILER BUY. The developments and refinements found in our Scotch Marine boilers today are the fruit of longest experience and largest volume manufacture of this famous boiler type—steady progress that pays off in *value* to every user. Write for quotations on the capacity you require.

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TITUSVILLE, PENNSYLVANIA
Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement
Plants at Titusville, Pa. and Warren, Pa.
Offices in Principal Cities

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145 Oil Controls, Oilers — Circular 580 presents company's Alvor constant level oil controls, bottle oilers for plain bearing lubrication; glass body oil cups, and aluminum body oil cups. Fully illustrated, circular includes detailed dimensions and installation instructions covering many applications. Lunkenheimer Co.

. . . *Outstanding Among This Month's Catalogs*

146 Service Entrance Guide — Known as the 1956 Quick Guide, Catalog TCD-17, 36 pp, contains pricing information and detailed descriptions of service entrance devices for commercial and light industrial installations. Covers circuit breaker load centers, all-in-one meter socket-load center combinations, fuse puller switches, meter service entrance switches and both standard duty and general use safety switches. Also contains applications and selection data. General Electric Co.

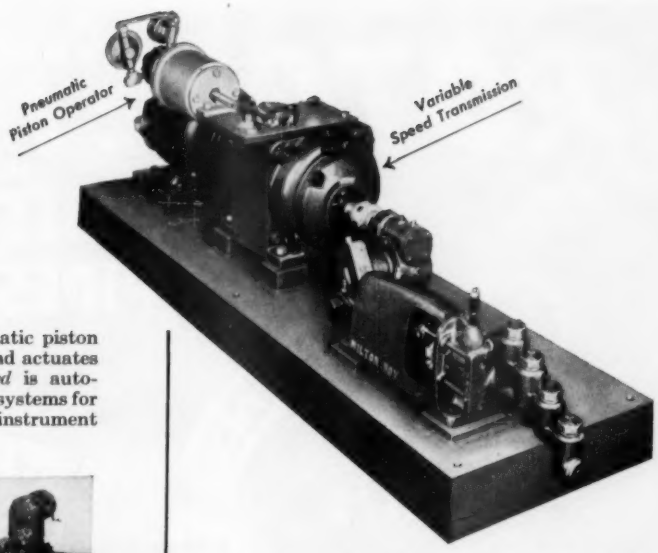
147 Corrosion Prevention — "Guard Against Corrosion" is a 26-pp bulletin on causes and control of corrosion. Explains seven types of corrosion and suggests methods of surface treatment for maximum control. Product information is included on Steel-Kote, Kork-Kote, an asphaltic primer, an asphaltic rejuvenater, a rubberized calking compound, a resinous aluminum coating, and Hi-Heat aluminum coating. Also provides chart showing degree of protection offered against 81 corrosive agents. Other sections deal with use of primers and finishing of industrial insulation. Vibradamp Corp.

148 Torque Manual — The 28-pp second edition of this company's popular torque manual includes additional torque application formulas, also more suggested torque application illustrations. New tables show screw torque data including minimum torsional strength tabulations, torque and tension relationship charts for high tensile and mild steel screws and torque conversion tables. Explanations and solutions to adapter problems and illustrations of special torque wrench adapters and attachments, and information on principles of torque wrenches are presented. The P. A. Sturtevant Co.

149 Stainless Steel Tubing — Points to be considered when purchasing welded stainless steel tubing are detailed and illustrated in this 12-pp brochure. Treats such topics as process, manufacturer, chemical composition and analysis. Shows how company's Electrunite Enduro stainless steel heat exchanger and condenser tubes are made to conform, in some cases exceed pertinent ASTM specifications. Means by which the tubing is made to achieve uniformity in surface, size, ductility, strength are described. Steel and Tubes Div., Republic Steel Corp.

ELECTRICAL EQUIPMENT

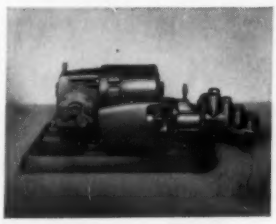
150 Explosion Proof Motors — Bulletin GEA-6341, 8 pp, discusses design features and maintenance of new induction motors, one through 30 hp, for use in hazardous locations. Photos illustrate the text. General Electric Co.



In this Controlled Volume Pump, a pneumatic piston operator receives an instrument air signal and actuates a variable speed transmission. Pump *speed* is automatically adjusted to process demand. Servo systems for automatic adjustment of stroke *length* by instrument air signal also available.

This pump is a 4-cylinder formulating unit. All liquid ends are powered by a variable speed drive, manually adjustable. Stroke length of each liquid end is individually adjustable, manually.

Standard motor-driven, simplex-controlled volume pump, with constant speed motor and manual adjustment of stroke length.



This formulating pump has two "miniPumps" (capacities in milliliters per hour) and one standard motor-driven pump, all powered by one constant speed drive. Stroke length of each unit is manually adjustable while pump is in operation.

Which pump is best for YOU?

Write today for application data on Controlled Volume Pumps in:

Paper Making (Bulletin 455)
Industrial Water Treating (Bulletin 953)
Process Instrumentation (Bulletin 1253)

Broad flexibility for metering process additives

If you pump and meter chemicals against a head . . . or maintain fixed ratios of two or more chemical streams . . . or automatically regulate flow of a control agent in a control system, such as pH, there's a Milton Roy Controlled Volume Pump that's exactly *right* for your application.

Illustrated are a few of many flexible adaptations in simplex, duplex and formulating pump designs that are available from Milton Roy, with manual or automatic adjustments of stroking length or speed. Capacities range from 3 milliliters per hour to 45 gpm, pressures up to 50,000 psi. Accuracy of delivery is within plus or minus one percent. Liquid ends are furnished in a wide selection of alloys and in plastic. Sanitary design, too.

Have you investigated how you can reduce chemical costs and upgrade product quality by using controlled volume pumps? One of the bulletins listed probably contains the economical answer to your chemical metering problem. Milton Roy Company, Manufacturing Engineers, 1300 East Mermaid Lane, Philadelphia 18, Pa.

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Cleans TUBES and PIPES

ANY SIZE

from ½" to 12" I.D.

STRAIGHT or CURVED

Roto engineers are constantly designing new equipment to meet new conditions and applications for its tube cleaners. If you have a pipe or tube cleaning problem, we will be pleased to place our long specialized experience at your disposal. Write, wire or

Phone HUmboldt 3-0570

Illustrated are a few of the many types and sizes of Rotojet Tube Cleaners driven by air, steam or water. We analyze each application before recommending equipment that best meets the requirement.

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Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

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151 Distribution Arrester — Company's Thyrite Magne-valve distribution arresters are described in Bulletin GEA-6379, 16 pp. Explains features of the arresters, which use magnetic action of series gaps coupled with valve action of Thyrite disks. Tabular data on specifications and applications are included. General Electric Co.

152 Motor Control Centers — Catalog 2-2000, 28 pp, features a compact motor control unit designed for industrial, laboratory and commercial applications. Describes 7-in. high motor control units, believed to be the smallest production-built plug-in types available, permitting plug-in of as many as 20 NEMA size 1 combination motor starters in a standard 90 in. back-to-back section. Construction details, components, and engineering data, including dimensions and specifications, are given. Federal Pacific Electric Co.

153 Precision Relays — Bulletin MRM 240 features general descriptive and engineering data on precision relays for alarm signalling and on-off operation of electrical loads, for actuation by American-Microsen transmission or control systems signals. Design and operating specifications are included. Manning, Maxwell & Moore, Inc.

154 Metal-Clad Switchgear — Design and construction features of indoor and outdoor 13.8-kv horizontal drawout metal-clad switchgear with Ruptair magnetic circuit breakers are described in 8-pp Bulletin 18B8142. Shows how the heavy component parts are located toward the bottom of the breaker for a low center of gravity and good stability. Also explains quick disassembly of breaker and operational advantage of horizontal contact separation. Allis-Chalmers Mfg. Co.

155 Automatic Transfer Switch — This illustrated bulletin covers circuitry and mechanical features of the Trans-O-Matic automatic transfer switch. Describes applications and includes schematic drawings showing optional transfer circuits available, and line drawings illustrating dimensions. Lake Shore Electric Corp.

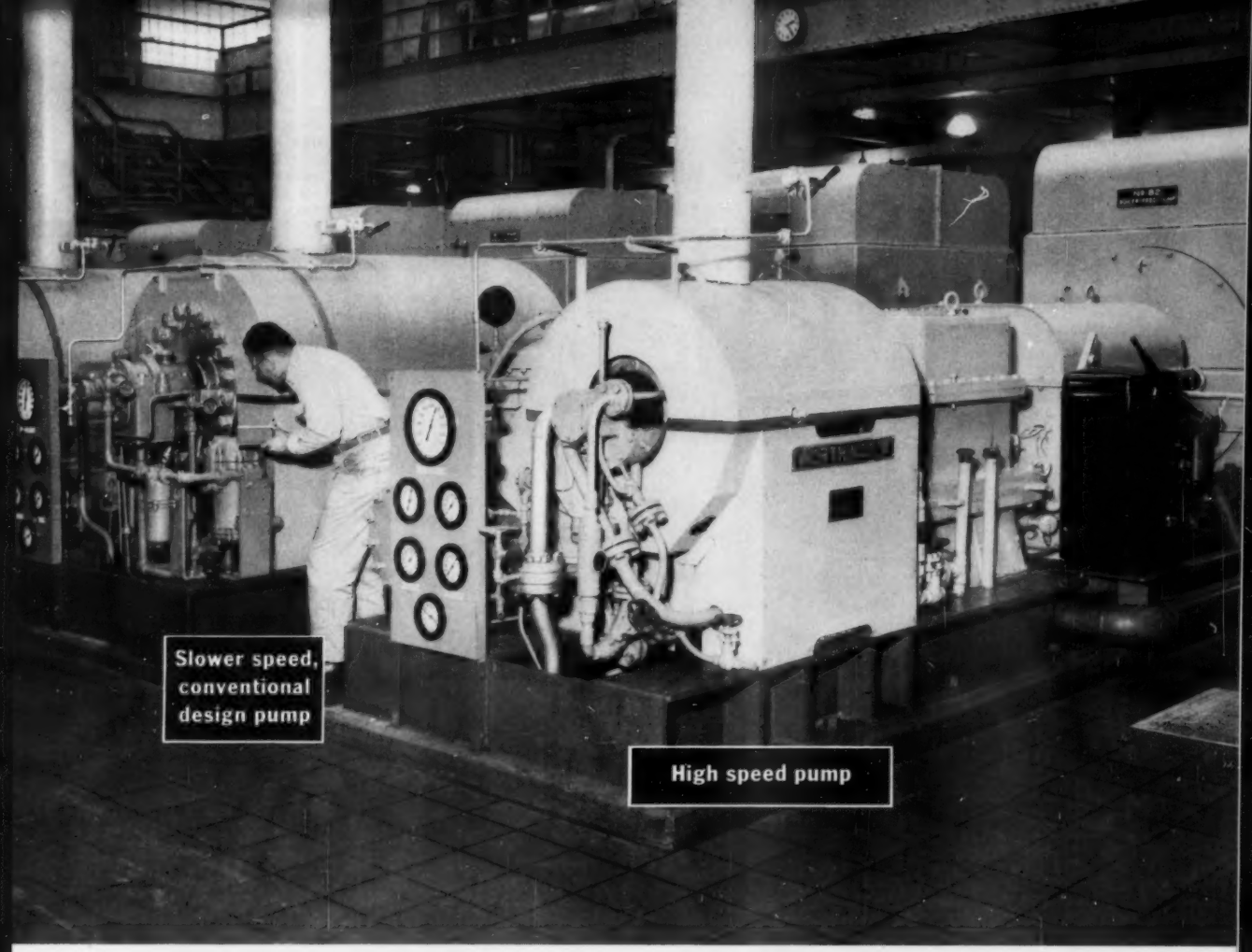
156 Transformers, Autotransformers — Twelve-pp pocket-size. Bulletin GED-2506A gives at-a-glance information on bucking or boosting voltage, connection diagrams, kva ratings, and other features on selection of dry-type BB transformers, autotransformers. General Electric Co.

157 Power Circuit Transformers — Bulletin P 561-16, 12 pp, features dimensions and data on power circuit transformers designed to provide the right voltage for any normal application within the operating range of the unit. Application data and wiring diagrams are included. Jefferson Electric Co.

158 Ballast Selection Guide — Twelve-pp Bulletin GEC-983H, on fluorescent lamp ballasts, contains new data on weatherproof units. Also provided are wiring diagrams, list prices and electrical specifications. Includes ballasts for general line fluorescents, plastic signs and outdoor applications, dimming and flashing, germicidal fluorescents, rapid start and circline lamps, others. General Electric Co.

FANS, VENTILATING

159 Fans for Severe Service — Industrial fans designed to handle corrosive and explosive fumes, high temperatures



6,000..8,000..10,000 rpm?

How much speed for modern boiler feed pumps?

With the trend towards superpressure power plants, a new look is being taken at existing boiler feed pump designs.

It's apparent that pressures as high as 5,000 psi cannot be reached economically at conventional speeds of 3,600 rpm without sacrificing reliability.

The 9,000 rpm Worthington pump above breaks through the speed barrier. Alongside a conventional unit with duplicate pressure and capacity ratings, its smaller size is dramatically evident. And this means greater reliability, lower costs. In operation since 1954, it has given satisfactory and reliable service in the new Kearny Generating Station of Public Service Electric and Gas Company, Kearny, N. J.

Twenty-two more Worthington high speed pumps on order. Speeds range from 6,500 to 9,000 rpm. If necessary, Worthington sees no reason why operating speeds shouldn't go even higher, without departing from experience-proved construction principles.

For more information, get in touch with your nearest Worthington District Office. If you'd like a copy of Bulletin RP-703, an interesting discussion of "High Speed Feed Pumps For Superpressures," write to Section C65, Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont. C-6.5

WORTHINGTON

CONSISTENT

Plant Production depends on

COLD WATER

Whether your end product is kilowatts, chemicals or candy, production is so closely aligned to consistent cold water temperature that your cooling tower is a most important element of plant equipment. This puts a premium on tower performance . . . and it points up Marley as the logical, economical selection for high-potential plants.

There are two major factors that qualify Marley industrial towers for critical cooling jobs: first, the initial performance is never in doubt; the cooling ability of every Marley tower is pre-determined. Fan, distribution, filling—every functional element—is pre-rated by the method developed by Marley's 35 years of specialized research and proved by scores of service tests.

Continuance of top-level tower performance is a single responsibility, for Marley designs and manufactures every component of its towers. It's a responsibility that Marley completely and gladly accepts. To translate this policy into action and to assure long-continued performance at specified temperature level, qualified Marley Field Service Engineers observe and check large industrial towers at frequent intervals. Their training and practical experience in tower operation and maintenance assists owners and operators to maintain the consistent cooling service that means plus production and increased operating profit.

MARLEY

Founder Member Cooling Tower Institute

The Marley Company

Kansas City, Missouri

For more data circle 523 on Post Card

and humidity, abrasive dusts and dirt-laden air, are shown in 6-pp Bulletin 620. Discusses applications for the belt-driven tubeaxial fans and requirements for use under special conditions. Fully illustrated, bulletin covers construction features, accessories, bearing assemblies and performance of five sizes with air delivery ratings to 26,000 cfm. Propellair Div., Robbins & Myers, Inc.

160 Controllable Pitch Fan — Bulletin A-113 describes a controllable pitch heat exchanger fan, designed to fill the need in the process industries for a precise method of maintaining fluid outlet temperatures. Typical control diagram is included. Hartzell Propeller Fan Co.

OTHER EQUIPMENT

161 Electrical Insulation — Advantages of Fiberglas-base insulation materials are described in this 6-pp folder. Such qualities as high thermal endurance, reduced space factor, high moisture resistance and other properties of Fiberglas tapes, braids, and cloth are stressed, and comparison graphs showing properties of Fiberglas-base materials and those using other kinds of textile bases are included. Owens-Corning Fiberglas Corp.

163 Vapor Condenser — Bulletin 129R features engineering data on the Aero vapor condenser, with diagrams and photos illustrating operation. Pictures units cooling reflux liquids and condensing vapors at top of distillation towers. Niagara Blower Co.

164 On Pre-Cast Stacks — This 80-pp engineering file on company's pre-cast insulated stack is indexed into four categories: general information; specifications and ordering data; installation instructions, including guying methods; and performance and physical characteristics, including test data. The stack described is an all-fuel refractory stack for use with boilers, furnaces, ovens and incinerators where flue gas temperatures do not exceed 1600 F for continuous exposure. Book is available to qualified power engineers. Van Packer Corp.

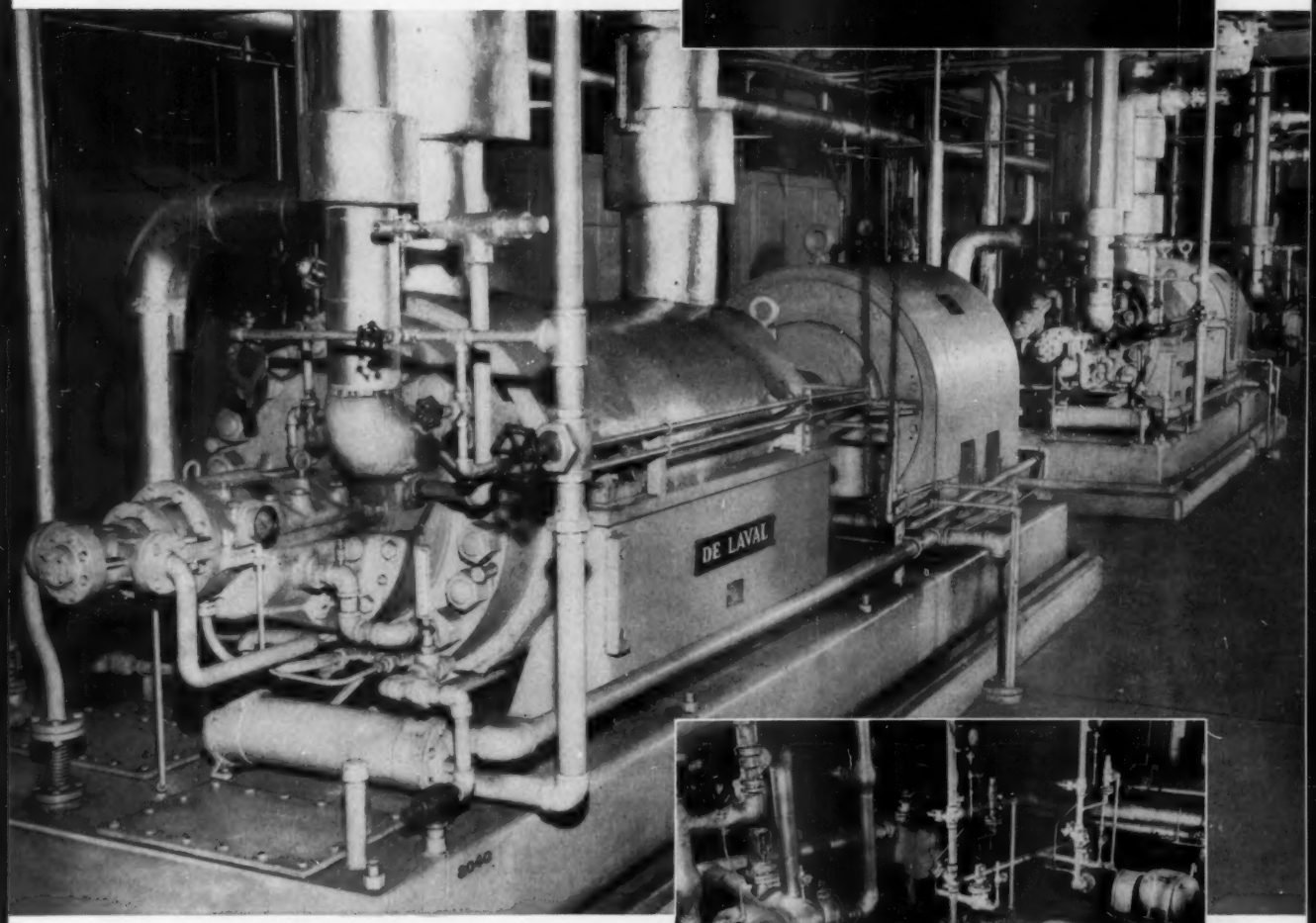
165 On Chemical Cleaning — This series of seven folders covers the intangibles behind the chemical cleaning service offered by the company, such as training of cleaning specialists, accepted cleaning methods, safety consciousness, research, chemical cleaning equipment and service. Dowell Inc.

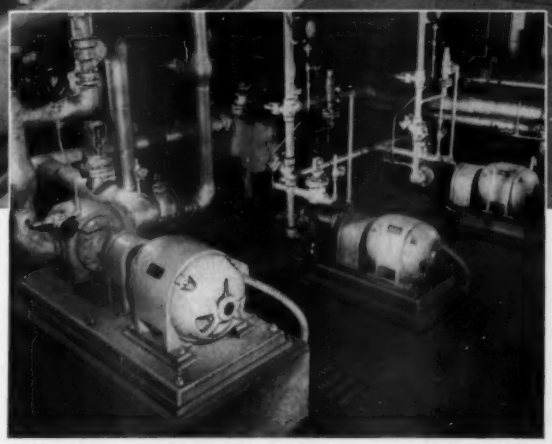
166 On Aluminum Bronze — "What's New in Aluminum Bronze," is an 8-pp comprehensive report. Illustrated with tables, charts and photos. Covers the development of nickel-aluminum bronze for marine propellers, and the application of the material in power, electrical, metal working and process industries. The International Nickel Co., Inc.

167 Comparative Plant Study — Economic advantages and disadvantages of the supercritical-pressure steam power plant, as compared with a conventional-pressure steam power plant are treated in Bulletin O3R8432, 16 pp. It presents a design for a turbine operating at 3500 psig 1150 F inlet conditions. Design and operational features of other components of a supercritical cycle are discussed, and an economic evaluation of the estimated station incremental costs of heat-rate gains is given. Allis-Chalmers Mfg. Co.

Atlantic City Electric ... another utility using

DE LAVAL
BARREL TYPE BOILER FEED PUMPS





De Laval IMO rotary positive displacement pumps handle heavy fuel oil. They are used for standby operation.

Atlantic City Electric Company knows it can count on De Laval reliability. Three De Laval high pressure, barrel type boiler feed pumps are on the line at their Deepwater Station in Penns Grove, New Jersey. These 10-stage units deliver 675 gpm, operating at 1762 psi with temperature at 287 F. The pumps are driven by 900 hp motors.

De Laval barrel type boiler feed pumps operate at pressures up to 5500 psi. These units offer many important design advantages, such as double volute diaphragm, individual diaphragm bolting, only one inner high-pressure joint, and bare shaft construction. Their dependability is proven by year in, year out service in public utilities and industrial plants.

Send for De Laval Bulletin 1506, which contains helpful data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY
816 Nottingham Way, Trenton 2, New Jersey

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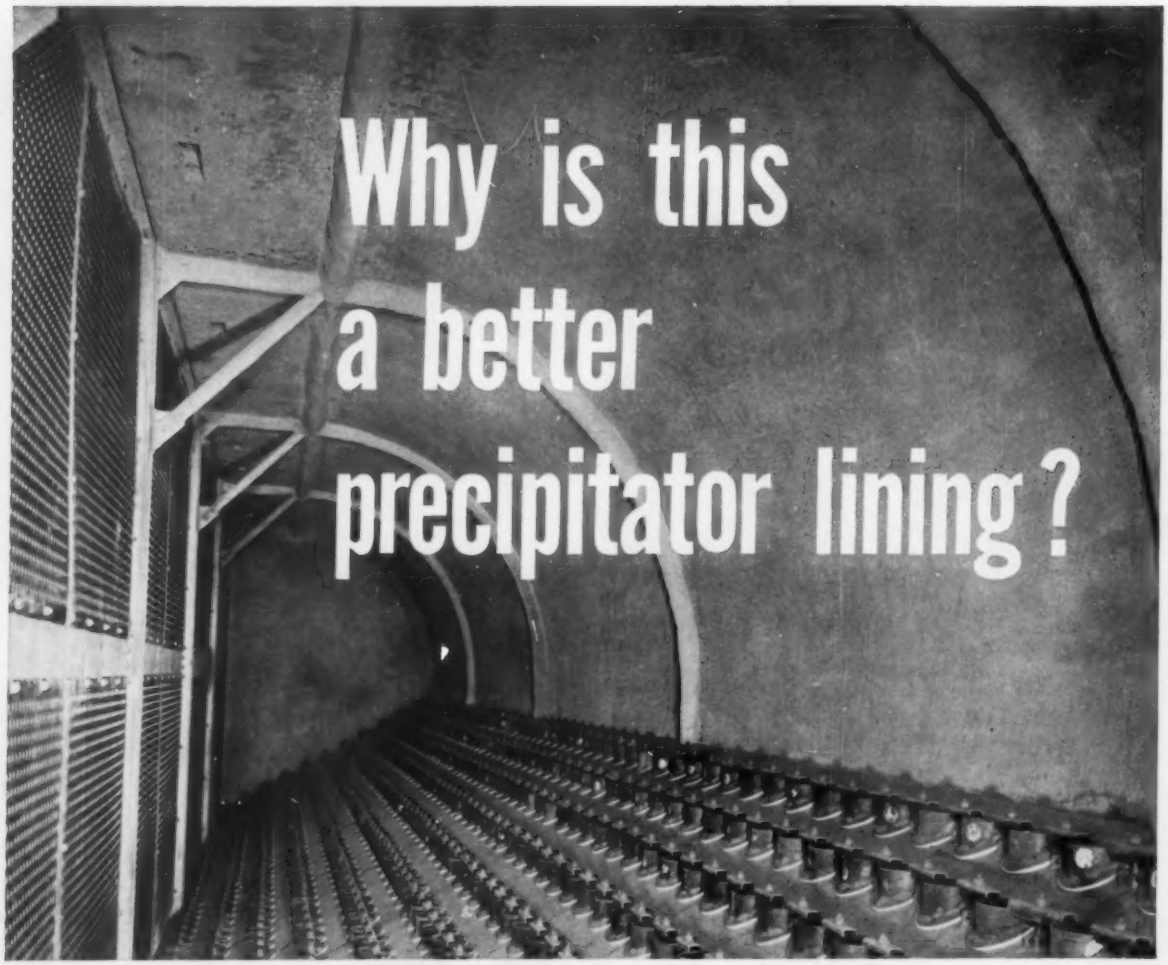

because **LUMNITE*** - concrete linings give trouble-free service, year after year

Where temperature and abrasion can cause excessive wear — as in above multiclone ash precipitator — plant operators are using Lumnite-concrete linings. Once installed, Lumnite industrial concretes give rugged resistance against heat, corrosion, abrasion and thermal shock, while reducing repairs and downtime to a minimum.

You'll find, too, that concretes made with Lumnite calcium-aluminate cement are easy to place, and *stay* in place, whether they are poured, troweled, or gunited. And, for maximum convenience, you can use a Lumnite-base castable. Because these are pre-mixed and ready to use, castables give uniform performance and are especially handy in emergencies. Lumnite-base castables are made and distributed by leading manufacturers of refractories. For more information, write:

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L-129

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FOR INDUSTRIAL CONCRETES

REFRACTORY • INSULATING • OVERNIGHT • CORROSION-RESISTANT

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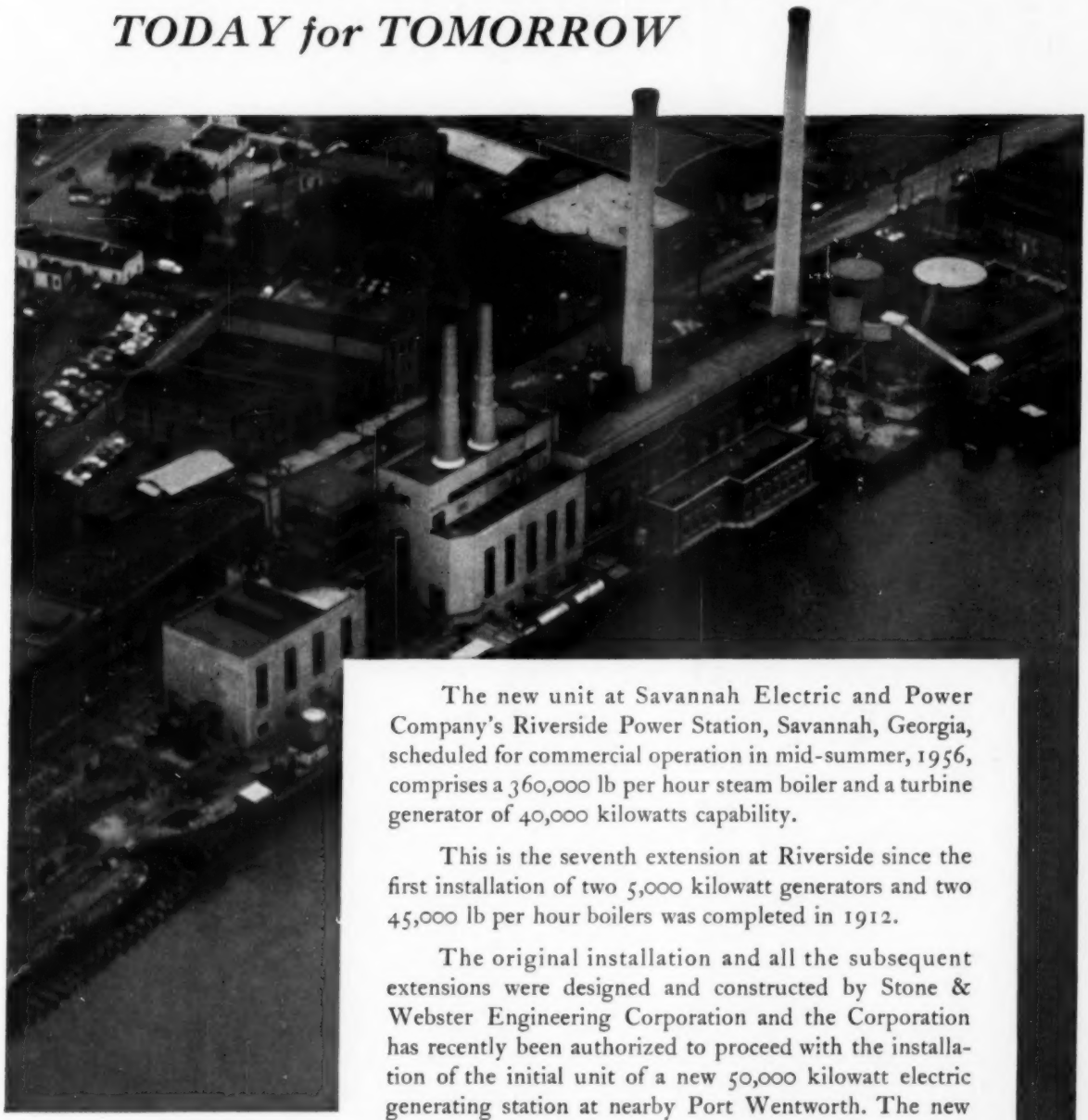
SAVANNAH ELECTRIC PREPARES *TODAY for TOMORROW*



The new unit at Savannah Electric and Power Company's Riverside Power Station, Savannah, Georgia, scheduled for commercial operation in mid-summer, 1956, comprises a 360,000 lb per hour steam boiler and a turbine generator of 40,000 kilowatts capability.

This is the seventh extension at Riverside since the first installation of two 5,000 kilowatt generators and two 45,000 lb per hour boilers was completed in 1912.

The original installation and all the subsequent extensions were designed and constructed by Stone & Webster Engineering Corporation and the Corporation has recently been authorized to proceed with the installation of the initial unit of a new 50,000 kilowatt electric generating station at nearby Port Wentworth. The new station is part of the Company's program for keeping ahead of the area's rapidly increasing industrial and residential power requirements.

Eighty per cent of the Engineering Corporation's construction work since 1889 has been in the nature of "repeat orders" from previous clients.

Write or call for our new booklet, "How Stone & Webster Engineering Corporation Can Help You".

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY of STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

POSITIVE PROTECTION
AT ANY PRESSURE...
specify Consolidated

Get protection you can be sure of — whatever your working pressure. Specify Consolidated Safety Valves. Thousands of installations, in both large and small steam generating plants, attest to their complete reliability under all types of service conditions.

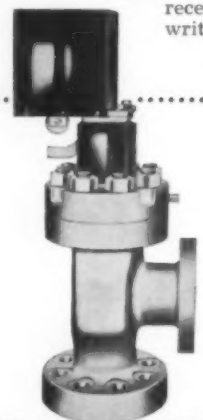
Many Consolidated Valves, with bronze body, are widely used for steam, air and water service; many more are installed in power plants as auxiliaries to Consolidated Steel Safety Valves. The cast iron and steel types are proving their dependability daily on low pressure boilers and those operated at super-critical pressures. The five different Consolidated Valves pictured here are representative types but the line is so complete, proper selection is no problem.

Consolidated Safety Valves are ruggedly built for long service life. Each type incorporates the fewest possible working parts for greatest efficiency. Precision craftsmanship assures positive, tight closing after operation. Through skillful engineering, valve adjustment and maintenance are made simple and easy. All these essentials contribute to outstanding performance, safety and economy.

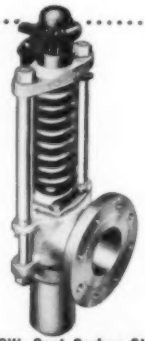
Just send us details of your particular service requirements and you will receive correct valve recommendations. Or write for Catalog 700A.

TYPE 1551. Cast Bronze Body. For package-type and fire tube boilers, air tanks and other classes of unfired pressure vessels. **Sizes:** ⅜" through 3". **Pressures:** up to 300 psi. **Temperatures:** up to 450° F.

TYPE 1511. Cast Iron Body. An all-purpose safety valve for steam generator service. Cuts cost per pound of steam discharged. **Sizes:** 1½" through 6". **Pressures:** up to 250 psi. **Temperatures:** up to 450° F.



ELECTROMATIC. Carbon Steel or Alloy Steel. An electrically actuated relief valve for boiler service. Operable automatically, manually or cut out of service by setting remote control switch. Supplements spring-loaded safety valves — conserves power and increases efficiency of steam generating plants. **Sizes:** 2½" through 14". **Pressures:** up to 2500 psi. **Temperatures:** up to 1100° F.



MAXIFLOW. Cast Carbon Steel or Cast Alloy Steel. A safety valve with the greater discharge capacity and shorter blowdown demanded by high pressure, high temperature steam generators. **Sizes:** 1½" through 4". **Pressures:** up to 2500 psi. **Temperatures:** up to 1050° F.

TYPE 1415. Cast Steel Body. For water tube boilers, mechanically fired fire tube boilers, accumulators, unfired pressure vessels and pipelines. **Sizes:** ½" through 6". **Pressures:** up to 900 psi. **Temperatures:** up to 900° F.

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, CONSOLIDATED SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more data circle 527 on Post Card

Which packing
for longer life in reciprocating service?

To 500F it's J-M Interlocked

because it cannot ravel or come apart

Made by an exclusive J-M process, Interlocked packing is braided from tough long-fibre asbestos yarns strongly interlocked in a solid integral structure. There are no jackets to wear through . . . no plaits to loosen. That's why it retains its strength and efficiency far longer than other types.

Interlocked also seals better. It is flexible and resilient, braided square for better contact and requires less gland pressure. Style 255 is effective against steam, hot or cold water, oil, weak acids and caustics. Furnished lubricated and graphited in ring and coil forms in sizes from ¼" and up.

To 750F it's J-M Superheat

because it does not harden under high heat

Designed specifically for superheated steam between 500F and 750F, Johns-Manville's Superheat packing is made of highest quality pure asbestos cloth which retains its resiliency even after long exposure to high temperatures. Woven tight, spiral wrapped and then pressed square, this cloth forms a firm resilient structure of superior strength and wearability.

Style 167 Superheat is bonded with a special heat resistant compound. No excess is present to carbonize in use. Density is carefully controlled for minimum gland pressure. Furnished graphited in ring and coil forms in sizes from ¼" and up.

Your local J-M distributor carries full stocks of Interlocked and Superheat and other packings. Call him today or write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

JM PRODUCTS

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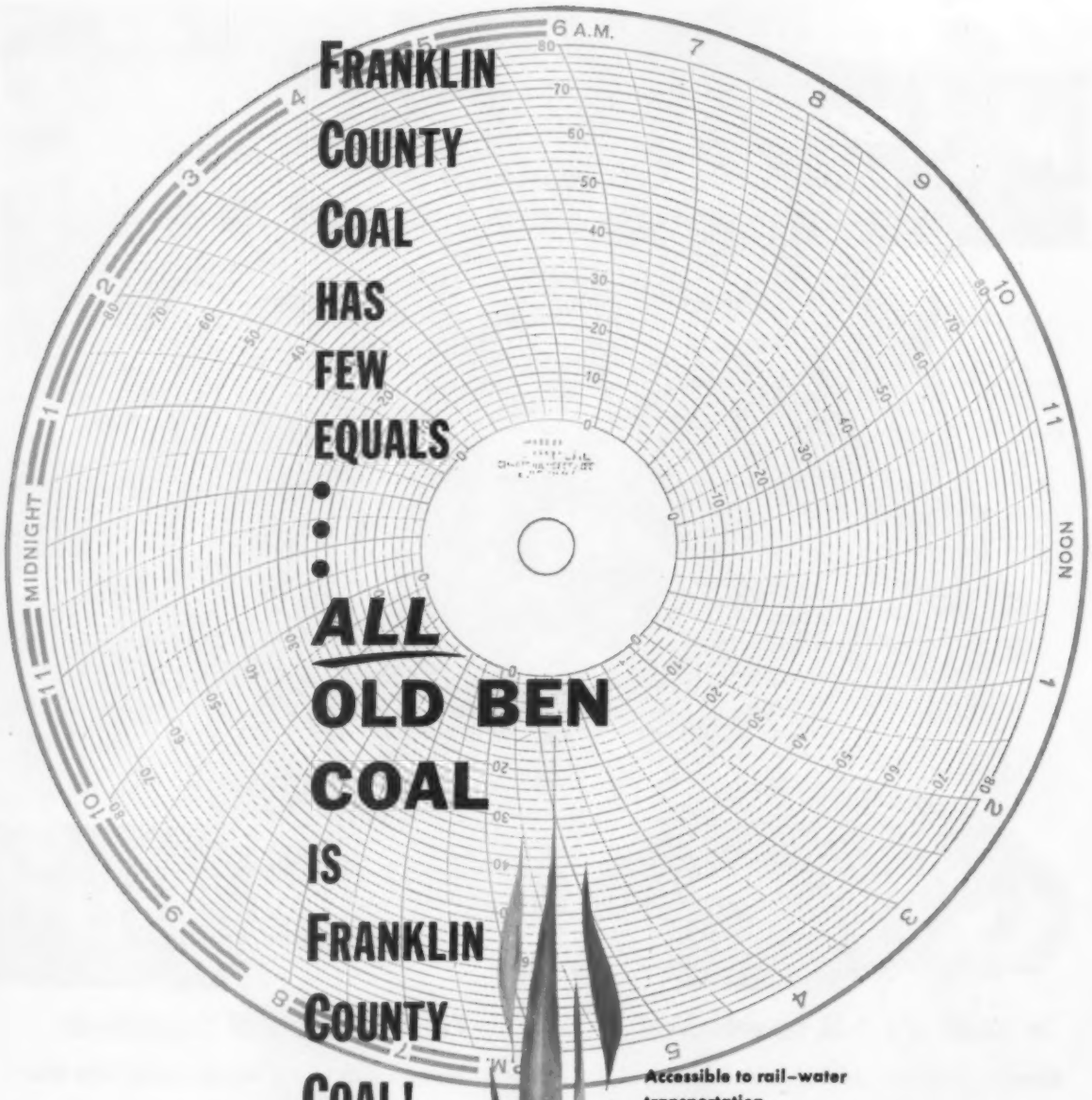
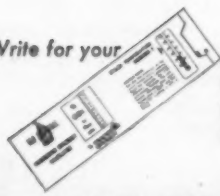
ALL OLD BEN COAL IS FRANKLIN COUNTY COAL!



Accessible to rail–water transportation . . .

OLD BEN COAL

. . . Wherever Heat, Light or Power is Needed



Write for your complimentary COMBUSTION EFFICIENCY CALCULATOR

OLD BEN COAL CORPORATION • CHICAGO 4, ILLINOIS

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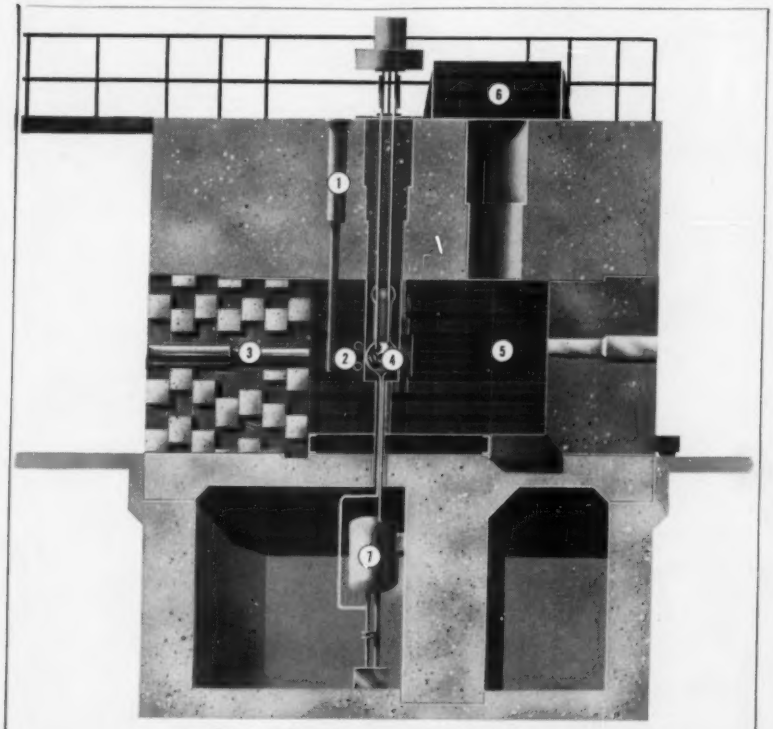
NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Aqueous, homogeneous type nuclear reactor being built for Japan

The first nuclear reactor for the Far East is being built by ATOMICS INTERNATIONAL for the Atomic Energy Research Institute of Japan. The reactor will be located near Tokyo. When the reactor starts operating early in 1957, a full program of research into the peaceful applications of nuclear energy will begin. This program includes the production of radioisotopes, studies in neutron activation, neutron diffraction, radiation effect on materials and training in reactor techniques.



Solution Type Research Reactor for Japan.

1 — Vertical thimble
2 — Pneumatic tubes
3 — Beam Tubes
4 — Central exposure facility
5 — Horizontal thermal column
6 — Vertical thermal column
7 — Gamma radiation area

At a rated power of 50 kilowatts, this solution type reactor will produce a peak thermal neutron flux of 1.7 x 10^{12}/cm^2 sec. Equipped with a five foot graphite thermal column, it will provide an extensive source of slow neutrons. Additionally, the room beneath the reactor housing the gas handling system has been designed to provide neutron-free gamma irradiation. This facility, ideally suited for biological and chemical experiments, will provide 50,000 curies of radioactivity in Xenon and Krypton gases circulating in the system.

The core of the reactor is a stainless steel sphere with a diameter of approximately 12 inches, filled with a uranyl sulphate solution. The fuel investment is approximately 1000 grams of Uranium^{235}. The reflector around the core consists of graphite stacked in a rectangular steel tank 5 feet high, 5 feet wide and 8 feet long. Appropriate holes for experimental facilities and instrumentation are located in the graphite. Five feet of dense concrete provides a shield around the reflector tank.

Instrumentation control is provided by two types of sensing elements which give neutron level information. In the power range up to approximately 1 watt, two fission chambers are employed. In the power range of approximately 0.1 to 50,000 watts, two gamma compensated ionization chambers are used. One of these chambers is fed into a shutdown channel and an electrometer which in turn sends a signal to the power level recorder. Power level is automatically maintained by feeding an error signal from the level recorder to a servo-amplifier which drives the regulating rod motor in the proper direction to correct error. The other ionization chamber feeds a logarithmic amplifier, and period shutdown circuit.

The core cooling system consists of a closed, recirculating system using demineralized light water. The core cooling loop includes about 90 feet of stainless steel tubing, the associated pump, valves and piping, and a heat exchanger to transfer the heat to a secondary cooling system.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. A reactor similar to the one scheduled for Japan has been installed for the Armour Research Foundation of the Illinois Institute of Technology in Chicago. It is one of several in-action nuclear reactors designed and built by ATOMICS INTERNATIONAL.

If you are interested in any phase of reactor technology, ATOMICS INTERNATIONAL is staffed and equipped to serve you. Please write: Director of Technical Sales, Department PE-N4, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

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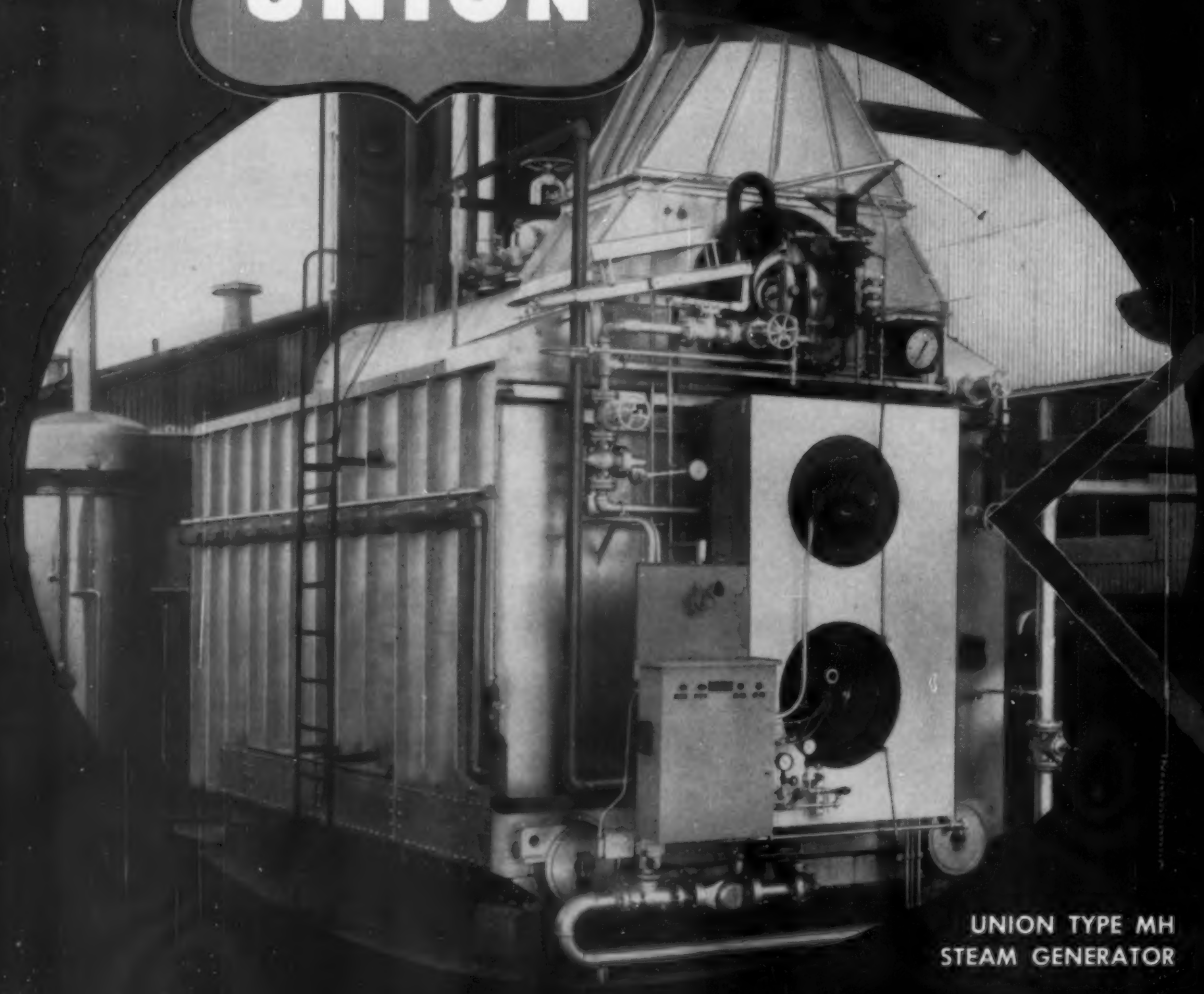
the PACKAGED BOILER

UNION



UNION TYPE MH
STEAM GENERATOR

Compare! Make a feature-by-feature appraisal of the modern Union Type MH Steam Generator. Here's the packaged boiler most apt to be **right** for you.

That's because the compact, 3-drum MH has not only been patterned after Union's larger, 16-year successful, field erected Type H, but it can be equipped to fulfill multitudes of steam requirements. No other packaged unit is so adaptable in meeting individualized needs within the 10,000 to 40,000 lb/hr range. No other boiler will do so much for **you**.

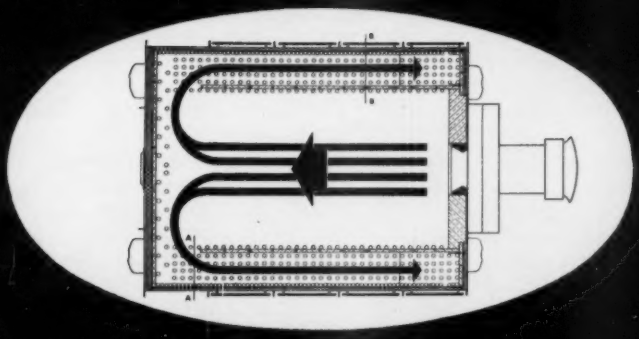
SEE FOR YOURSELF!

FREE: Illustrated, 16-pg Bulletin MH 354 will be mailed on request. Containing cut-away illustrations, installation photos, tube arrangement layouts and specs, it will give you the complete story. Write for your copy today.

UNION IRON WORKS

ERIE, PENNSYLVANIA

that "HAS EVERYTHING"



HIGH MASS GAS FLOW, HIGH HEAT TRANSFER

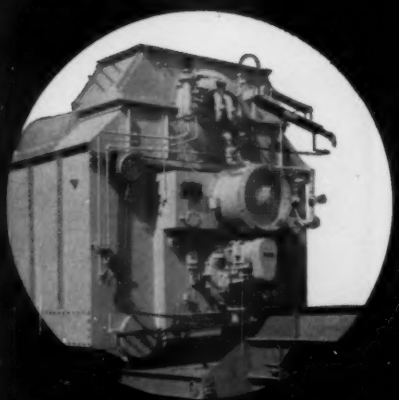
The straight-through gas flow over the divided tube banks requires furnace baffles only. Tube pattern provides high heat transfer and low exit temperatures without the higher draft losses of a staggered tube arrangement.

BALANCED, 3-DRUM DESIGN

A bare tube view gives you at-a-glance proof of the basic soundness of the MH design. There are no long furnace floor tubes, water wall headers nor circulator connections to impede circulation. The MH can be brought on the line quickly and will readily handle fluctuating steam demands.

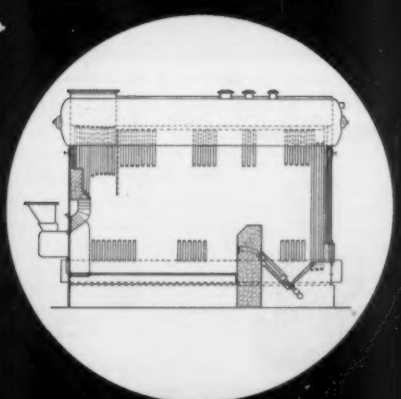
DIVIDED TUBE BANK, TANGENT TUBE WALL CONSTRUCTION

Divided tube banks enclose a self-contained furnace and provide multiple tube rows between furnace and casing walls. This arrangement and the use of tangent tubes in outer rows bring about minimum radiation losses and low casing temperatures.



MEETS PRESENT AND FUTURE FUEL NEEDS

The MH Steam Generator can be equipped for oil or gas firing or **both** . . . or for burning refuse or by-product fuel. It can be furnished with either fully automatic, semi-automatic or manual ignition and combustion control.



READILY ADAPTABLE TO STOKER FIRING

The MH is so designed that it may easily be converted to stoker firing . . . without requiring any changes in pressure parts. Installation is simple. With the furnace floor removed, only minor alterations need be made to the draft equipment.

OUTFITTED TO MEET YOUR SPECIAL REQUIREMENTS

Superheaters, of the pendant type, with or without control, can be installed to meet total temperature requirements. Heat recovery equipment is supplied when needed. High pressure units are also available for special applications.

PERFORMANCE VERIFIED / by acid test

Even before a Powell Valve is made, it must pass the acid test. For quality control of Powell Valves begins not with manufacture—but with the very materials which go into Powell Valves.

Constant laboratory control is one of the many ways we make certain that Powell Valves will give dependable flow control. Another is the final step of manufacture of these precision-built valves: *every Powell Valve is subjected to an actual line test.*

Because of Powell's painstaking quality control, valve repair is cut to the minimum and plant shut down through valve failure is substantially reduced. Records of performance the world over prove it.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE *quality line* which has PERFORMANCE VERIFIED.

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

PERFORMANCE **PV** VERIFIED

FIG. 3003 WE—Steel Gate Valve For 300 Pounds W.S.P.

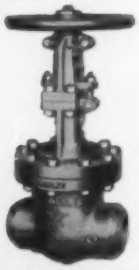


FIG. 11365—Steel Pressure Seal Horizontal Lift Check Valve For 1500 Pounds W.S.P.

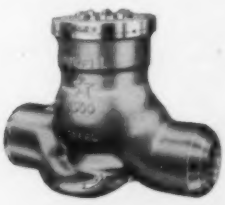
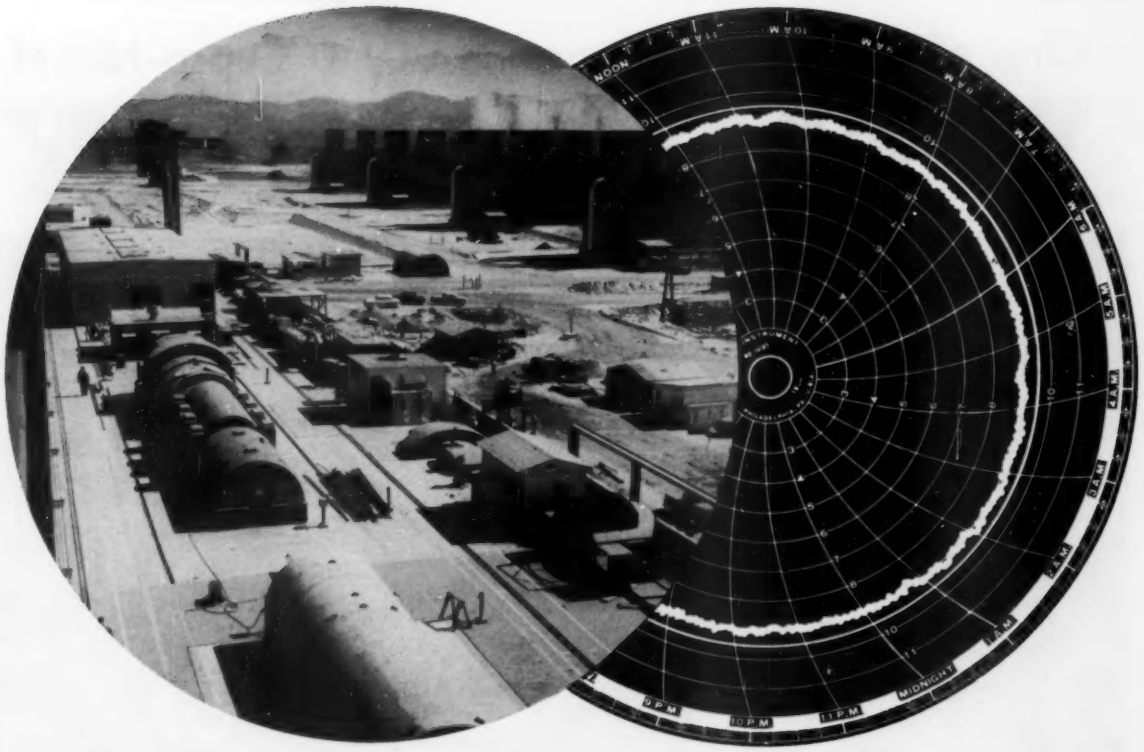


FIG. 11323—1500-Pound Motor Operated Steel Pressure Seal Gate Valve.

POWELL VALVES

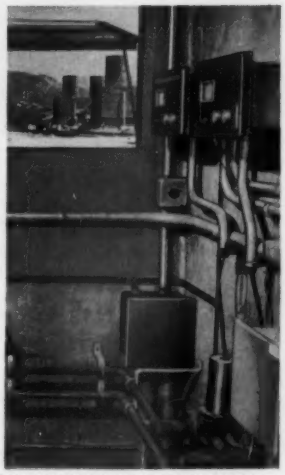
BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

For more data circle 532 on Post Card



San Fernando Valley Steam Plant checks corrosion with 18 Beckman pH Control Systems

WATER SYSTEM	NO. OF BECKMAN UNITS	pH RANGE	REASON FOR pH CONTROL
Raw Water Demineralization	2	8.0-9.0	Properly condition raw Owens River water.
Boiler Makeup	4	11.0-11.3	Prevent corrosion in wet stages of turbine and condensate systems.
Condensate	4	8.5-9.0	
Condenser Circulating	4	7.5-8.0	Protect efficiency, prevent corrosion, scale, deterioration in condensers, heat exchangers, cooling towers.
Turbine Bearing Cooling	4	7.5-8.0	Prevent corrosion, scale and algae deposits in turbines, piping and cooling towers.



Nowhere is the need for accurate and reliable automatic pH control more dramatically illustrated than at the 512,500 KW Valley Steam Plant, newest and largest power-generating facility of the Los Angeles Department of Water and Power. To prevent shutdowns and high maintenance and replacement costs, 18 individual Beckman pH systems help treat the plant's major water systems properly to avoid destructive corrosion, scale and deterioration in turbines, boilers, condensers, piping and cooling towers.

Exactly how Valley Steam uses Beckman pH instrumentation is outlined in the chart above. Valley Steam is one of the first power plants to use a centralized chemical control system whereby all boiler, and condensate sampling and treatment is done automatically from a single location. Reliable instrumentation here is vital.

Valley Steam Plant, serving residents of Southern California, relies on rugged and accurate Beckman pH measurement and control instrumentation for top operating efficiency today – and tomorrow. To learn how Beckman pH control can help you, mail the coupon today.

Beckman® *process instruments*

Beckman Instruments, Inc., Process Instruments Dept., Fullerton, California

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One of many advantages of 90/10 Cupro-Nickel

WELDABILITY

Welding head on filter shell

One of the relatively new copper base alloys is 90/10 Cupro-Nickel, which is coming into increased use as a result of experience with it. Revere offers it in sheet and plate, pipe and tube. It is highly resistant to corrosion and erosion, particularly in salt or brackish water. In addition it can be cold or hot worked, welded, soldered and polished. Because its nickel content is less than the older 70/30 alloy, it is priced lower.

The item shown here is a 90/10 Cupro-Nickel filter for aviation gasoline, designed and fabricated by the Warner Lewis Company, Division of Fram Corporation, Tulsa, Oklahoma, for the U. S. Navy. Heads and shell are 1⅛" thick. Revere was given the opportunity to collaborate with the Warner Lewis manufacturers on welding, which was successfully accomplished by the metallic arc process, using Inco 70/30 Cupro-Nickel electrodes. The vertical weld on the shell was X-rayed 100% and found satisfactory to pass Navy inspection. Because of the thickness of the metal, it was decided to form the heads hot at around 1690° F. The forming was done by the Hackney Iron & Steel Co., Enid, Okla., which also consulted with Revere.

Warner Lewis Company of Tulsa, with representatives in 30 cities, are specializing on all types of alloy design and fabrication and inquiries of this nature are invited.

If you wish information regarding the selection, welding, or working of copper and its alloys and aluminum alloys, see the nearest Revere Sales Office.

Completed aviation gasoline filter, made of 90/10 Cupro-Nickel

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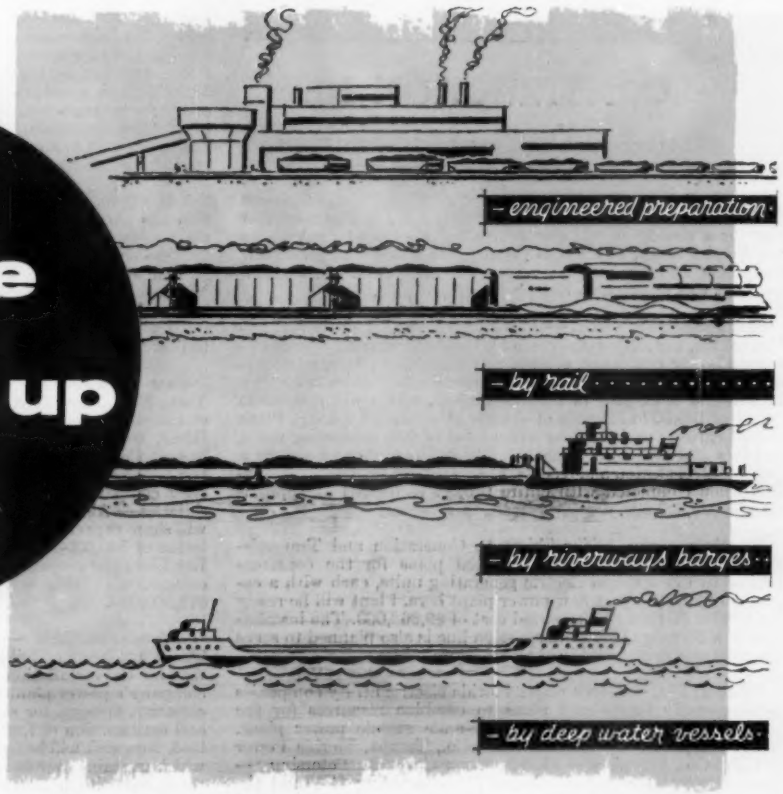

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CONSTRUCTION NEWS

Birmingham, Ala. — The Alabama Power Co., Alabama Power Company Building, Birmingham, Ala., has plans under way for a new hydro-electric generating station at Lock 13 on the Warrier River, Tuscaloosa County, Ala. Size of the generating equipment and plant capacity were not announced but installation cost was reported to be close to $25,000,000.

San Francisco, Calif. — The Pacific Gas & Electric Co., 245 Market St., has authorized plans for the construction of an underground power generating station on the Feather River, southeast of Jarbo Gap. New installation will be about 24 miles from Oroville and is to be part of the Poe project, which will provide in excess of 100,000 kilowatts of electric generating capacity. Plant almost entirely underground will consist of two generating units, turbines and control equipment. Visible above ground will be a small control station and a concrete switchyard building. Installation when completed with entire project estimated at approximately $35,000,000.

Sterling, Colo. — The Tri-State Generation and Transmission Association, Inc., has authorized plans for the construction of two new steam electric generating units, each with a capacity of 22,000-kw at new power plant here. Plant will be ready for service in 1958 at a reported cost of $9,968,000. The installation of a 20-mile 115 kv transmission line is also planned to serve the area and is included in the cost figure.

Miami, Fla. — Three major Florida electric utility companies have recently formulated plans to combine resources for the design and development of a large-scale atomic power plant. Three companies — Tampa Electric Co., Tampa, Florida Power & Light Co., Miami, and Florida Power Corp., St. Petersburg — have retained the Allis-Chalmers Manufacturing Co., and the Babcock & Wilcox Co. for consultation on the project scheduled to be in operation by late 1963. No estimate of cost announced at this time.

St. Petersburg, Fla. — The Florida Power Co., 101 S. Fifth St., is arranging and planning a bond issue of $20,000,000, portion of which is to be used in connection with current construction program covering power plants, transmission lines and other improvements to system. Florida Power has spent approximately $8,000,000 so far this year and estimates its 1956 construction expenditure at approximately $31,000,000.

Peru, Ind. — The City Council, City Hall, Peru, Ind., has authorized plans for the expansion and modernization of municipal power plant. A contract in the amount of $837,365 was awarded to the Allis-Chalmers Manufacturing Co., Minneapolis, Minn., to furnish and install a steam electric generator and turbine with an initial capacity of 22,000-kw. An additional amount of $743,817 was awarded to the Springfield Boiler Co., Springfield, Ill., for the boilers and installation of steam generating equipment.

Boston, Mass. — The Boston Edison Co., 39 Boylston St., has authorized plans for the expenditure of approximately $140,000,000, for construction, expansion and modernization over a five year period to keep pace with the rising demand for electric power in this area. Company also plans to reduce average age of 17 small generating units 25 years old or more by replacement. First of such units, a 25,000-kw generator, will be placed in operation at company's Mystic power plant in November, 1957, followed by a larger installation of 125,000-kw to be placed in service late in 1959. When both are completed company's total capacity will exceed 1,051,360 kw.

Boston, Mass. — The Western Massachusetts Co. has arranged financing in the amount of $4,000,000 to provide for construction costs estimated at $24,500,000 for the two years 1956–1957, and $16,000,000 for the three years 1958–1960. Main item in the company's five year construction program is a 100,000-kw turbine generator to be installed at West Springfield Station at estimated cost in excess of $16,500,000 scheduled for service in mid-1957. Company will arrange the sale of half station output when completed to August 1959 and smaller amounts thereafter until company demands for additional power increase.

Monroe, Mich. — The Power Reactor Development Co. has plans under way for the construction of an atomic power plant on the shore of Lake Erie, seven miles north of here. A contract award has been made to the Allis-Chalmers Manufacturing Co. for a 150,000-kw steam turbine generator to produce power from steam supplied by the reactor. To date company has invested $8,000,000 on conceptual design and another $2,000,000 on full scale reactor parts and hopes to place unit in operation by early 1960. Commonwealth Associates, Jackson, Mich., and United Engineers & Constructors of Philadelphia, Penna., have been retained as architectural and construction engineers, respectively.

Elk River, Minn. — The Rural Cooperative Power Association has announced that they have negotiations under way with the Atomic Energy Commission for permission to construct a 22,000-kw closed cycle boiler water reactor plant. AMF Atomics, Inc., a subsidiary of American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y., is consulting engineer. Work is expected to begin early in 1957 following completion of negotiations with the commission. Plant when completed is expected to cost about $9,310,000.

New York, N. Y. — The Southern Co., 250 Park Ave., New York, N. Y., has plans under way for the construction of a large steam electric generating station and power plant on the Coosa River, between Montgomery, Ala., and Rome, Ga. Company has organized a new concern to be known as the Southern Electric Generating Co. that will own and operate the giant station. New company, jointly owned by two Southern Company subsidiaries — Alabama Power Co., and Georgia Power Co. — will share capacity of new station on an equal basis. Initial installation of 500,000-kw will be made on the Coosa River between Lay Dam and proposed Kelly Dam. Steam generating plant to be completed in 1961 will represent an outlay of approximately $75,000,000.

Ashtabula, Ohio — The Cleveland Electric Illuminating Co., The Illuminating Building, Cleveland, Ohio, has plans under way for the installation of a new 250,000-kw turbo generator at company's power plant here which will more than double plant's capacity. Ground for structural work will be broken in the fall and construction of the generator itself has already been authorized. New unit will be housed in plant addition to present facilities which contains four 60,000-kw generators. Plant expansion here, combined with a major generating project at Avon Lake, will boost company's total operating capability about 28 per cent to a total output of 2,300,000 kw.

Johnstown, Penna. — The Pennsylvania Electric Co. has arranged financing in the amount of $20,000,000, proceeds of which will go toward the 1956 construction program. Funds will be used in connection with construction and expansion program to include property additions, increased generating facilities, transmission lines, and other general important improvements.

Columbia, S. C. — The South Carolina Electric & Gas Co., 328 Main St., has arranged financing in the amount of $5,000,000, by preferred stock issue, proceeds of which will be used in connection with current construction program. Company plans to spend $14,500,000 in 1956, $59,000,000 in 1957 and a like amount in 1958, for increased power generating facilities, transmission lines, power substations and improvements in operating facilities.

Bridgeport, Tex. — The Brazos Electric Power Co-operative, 902 Amicable Building, Waco, Tex., has plans under way for power plant expansion at local site here. Work will include installation of a new 33,000-kw steam electric generating unit, boiler and switching stations along with the installation of a 108-mile new transmission line. Cost of installation reported to be $7,500,000.

Bryan, Tex. — The City Council of Bryan, Tex., has approved a bond issue and has plans maturing for proposed improvements to municipal electric generating plant to increase present capacity. Improvements and expansions of present system are expected to cost approximately $2,885,000.

Monahans, Tex. — The Texas Electric Service Co., 406 West 7th St., Fort Worth, Tex., has authorized plans for a single unit electric power generating plant in Permian Basin, near here. Initial installation of power generating unit and equipment will run an estimated $15,000,000. Provisions for storage units and some power lines will run an additional $100,000 and $200,000 respectively.

Menomonie, Wis. — The Northern States Power Co., 4 S. Barstow St., Eau Claire, Wis., has authorized plans for the construction of a dam and generating plant for hydro-plant redevelopment on the Red Cedar River, near here. Ashbach Construction Co., 1910 West County Road C, St. Paul, Minn., have the construction contract for the project estimated to cost about $2,803,300.

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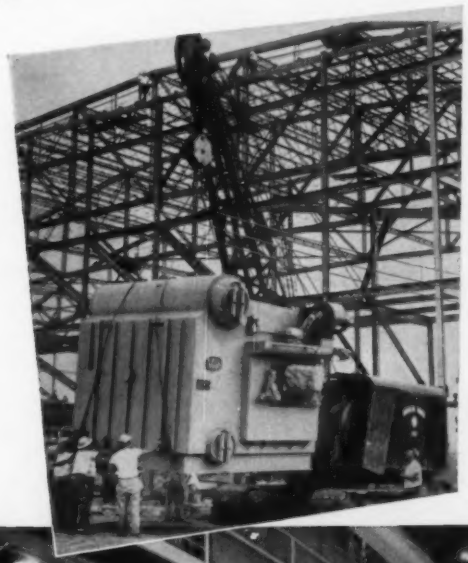
STEAM GENERATORS by Vogt

a guide to advanced designs in package unit and custom built steam generating equipment



Vogt steam generating units are available in types and sizes to meet individual plant needs for power, processing or heating.

Package units range from 10,000 to 40,000 pounds of steam per hour while custom built units are obtainable in the larger capacities. Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid or gaseous fuels burned singly or in combination.

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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 121–122 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—CHEMICAL PACKING has increased corrosion resistance

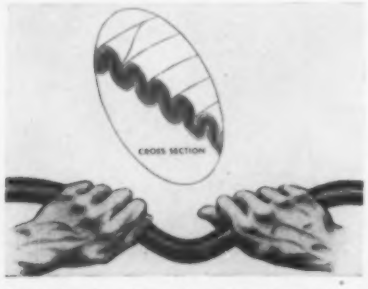
The newly developed fiber used in this company's 405 Mechanical Packing is said to offer greater corrosive resistance and service life. Packing is a braid over braid of glass and Teflon — two of the most inert of fibers. Teflon fibers braided over a core of glass fibers and impregnated with Teflon presents a soft pliable low friction packing, it is said, that is excellent for use on centrifugal as well as reciprocating and static applications. It is reported to give excellent performance under wide environmental conditions of temperature and chemical exposure. According to manufacturer, concentrated acids such as sulphuric, nitric, aqua regia, as well as sodium hydroxide, other alkalies, and most solvents are easily handled. Abbott & Biddle.

2—CLEANING ROD swabs inside of liquid level gages

To use this cleaning rod you slip a tubular cloth swab over a piece of corrosion-resistant spring steel on the end of the rod, apply a detergent or other cleaning medium to the swab and insert the rod into the end connection of the gage or the drain in the offset of a valve. When the swab is visible in the glass, you simply pull back the handle and tighten the thumb screw. The result is an increased arc of the spring which forces the swab against the glass — permitting a good cleaning job with little effort. Rods come in standard lengths of 36 in., cost less than $32.00. Longer ones may be ordered. Jerguson Gage & Valve Co.

3—FLEXIBLE TUBING features installation advantages

Announced as possessing unusual installation advantages, Plica Tubing has been in use abroad as electrical conduit, and is claimed to be ideal for burying in concrete, ceilings and floors. As it can be cut with a hacksaw or knife,



bent by hand to stay bent, and fits all standard connectors, installation times are substantially reduced, it is noted. Plica has a three-ply wall and can be made in almost any combination of ferrous and non-ferrous metals, fiber, paper and other materials. Tubing is made in continuous lengths. It is described as having high wall strength, watertightness and sharp bending radii. Plica tubing, made of copper, brass, aluminum, steel, asbestos, fiber, paper and combinations of these materials, is used for lubricating, coolant and other non-corrosive liquid lines, hot and cold air ducts, mechanical protection and insulation of pipes, flexible shaft casing. Sizes are ⅜ through 2 in. ID. Bulletin 61 gives data. The Flexaust Co.

4—STORAGE BATTERY is high output, nickel cadmium type

Announced as featuring exceptionally long life and durability even under severe environmental conditions is this high output, nickel cadmium pocket plate storage battery. It is suggested for diesel engine starting, standby power, switch tripping and closing and emergency lighting. The active materials, nickel and cadmium oxides, are locked in finely perforated steel pockets formed into plates. Cell containers are steel. The electrolyte is a solution of potassium hydroxide. Manufacturer points out that no corrosive fumes are given off either charge or discharge, and that the low cost maintenance and dependability of this battery are of particular value for remote or unattended locations. Nickel Cadmium Battery Corp.

5—LIGHTWEIGHT HOSE made of synthetic materials

Declared capable of handling air continuously at temperatures up to 400 F and working pressures of 100 psi, this hose can be made with inside diameters of from ¾ to 5 in. in lengths to 50 ft. Constructed entirely of synthetic materials, the hose is claimed exceptionally strong, lightweight and flexible. Quaker Rubber Div., H. K. Porter Co., Inc.

6—CENTRIFUGAL FANS feature improved blade design

The Series 6000 Silentvane Centrifugal Fans with Airfoil blading make possible 92 per cent peak mechanical efficiency, it is announced, and 88 per cent static efficiency in the movement of air in high pressure air conditioning and industrial process ventilation. Airfoil type blading is not only responsible for these high efficiencies, it is pointed out, but this blade design lowers noise energy perceptibly as compared to most flat-bladed centrifugal fans. Low operating cost is reported since maximum horsepower is attained within normal range of fan selection. Fans are designed for direct connection to conventional squirrel cage induction motors operated at standard motor speeds. For applications requiring regulation of air output over a wide range of operating conditions, inlet vane control is available operated either manually or automatically. Sixteen models have wheel diameters from 27 to 108 in. Westinghouse Electric Corp.

7—ION EXCHANGE RESINS, high-capacity anion type

Now available in commercial quantities are the Duolite A-100 Series of high-porosity, high-capacity anion exchange resins. Among jobs for which they are suggested is production of high quality boiler feed water. Their efficiency is attributed to their method of manufacture, in which a new cross-linking process is utilized to form a resin with true porosity and a known, controllable degree of cross-linking. This is claimed to result in longer life, ability to handle larger molecules, greater resistance to organic fouling and more reproducible results. Also, conditions of activation are less severe than those of most activation processes, says company, and the resins have greater stability and contain less extractable residues. Furthermore, the manufacturing method is said to eliminate the "skin" effect common to many bead-form resins. Claimed to offer a long operational life and need less frequent restoration, the resins come in two strongly basic types, and a weak base type. Chemical Process Co.

8—PLASTIC CAP snaps into the bushings to seal them

This versatile plastic bushing cap snaps into conduit bushings, connector hubs and conduit ends, both rigid and EMT.

Installed with only finger pressure, the cap is said to assume its original shape and size to form a tight, protective seal during construction work. It may be snapped into either metal or plastic bushings, and installations can be made in the field. It comes in conduit sizes from ½ to 2 in. The Thomas & Betts Co.

9—HYDRAZINE for deoxygenation of boiler feedwater

Scav-Ox is announced as a 35 per cent solution of hydrazine in water, having neither flash point nor fire point, yet retaining advantages of hydrazine as an oxygen scavenger and corrosion inhibitor. It is claimed to eliminate many handling precautions formerly required, which restricted use of hydrazine to larger power generating stations. Ac-

This Crane valve on superheated steam since 1946—with no maintenance

You'll spot cost-saving performance in the record behind this Crane valve—it has been on duty an even decade of years, with no maintenance at all!

Neches Butane Products Company installed this Crane 8-inch, 900-pound Pressure-Seal angle stop-check valve in 1946 in its butadiene plant in Texas. On superheated steam boiler service, this valve has never failed to close tightly and surely—and operate smoothly and easily—with no sticking, no troubles—no need to go near it with a wrench.

There's no question that dependability is a must in service like this. Minimum restriction of steam flow—plus smooth, positive and quick seating on backflow—*must* be provided for safe, steady boiler operation. And Crane stop-check valves can do it—*have* been doing it for years and years.

Before you specify any valve, be sure to look into the advanced designs and materials, the broad selectivity and service suitability of the great Crane line. You'll find everything you need in valves and fittings—built to the highest standards of quality. Get full information from your local Crane Representative, or write to address below.

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cording to manufacturer, Scav-Ox provides operators of high pressure boilers with a safe and more convenient form of hydrazine — and makes possible its use in low pressure heating boilers.

Hydrazine is said to have several advantages over traditional oxygen scavengers, including higher oxygen removal efficiency which means that less of the material is required. A further advantage mentioned is that it does not put solids into water. Also, through its partial breakdown to ammonia, hydrazine further contributes desired alkalinity to boiler water, it is explained, and improves heat transfer by reducing ferric oxide scale in the boiler to magnetic iron oxide. As Scav-Ox, hydrazine can be fed continuously to boilers by a chemical proportioning pump leading into the feedwater line. It is noted that while Scav-Ox's cost per pound is higher than that of many water treating chemicals, its effectiveness offsets this. Olin Mathieson Chemical Corp.

10—TEMPLATE or plotting symbols for graphs, curves

No. 59 Plotting Systems Template has cut-outs used in making graphs and sketches and plotting curves. Made of amber colored plastic, the template is 6¾ in. long and costs around $1.00. Rapidesign, Inc.

11—VIBRATION MONITOR protects rotating equipment

The Model 5 Vibraswitch anticipates and prevents trouble in rotating and reciprocating machines, it is announced, by responding to slight increases in roughness or vibration and causing a shutdown before a costly failure occurs. Examples of detectable malfunctions are failing bearings, bent shafts, unbalance, broken blades. Applications include pumps, motors, compressors, blowers, gas engines, diesels, centrifuges, turbines, generating equipment, test stands. It may be used singly on small equipment; in pairs on driving and driven equipment, or in series or parallel combinations to monitor each bearing.

Unit includes a shock-free holding and reset mechanism for automatic or remote operation to prevent actuation from starting or from normal or accidental transient shocks. Instrument employs no vacuum tubes or electronic components, is claimed maintenance-free and fail-safe. It is supplied in an explosion-proof housing for Class I, Group D; Class II, Group F and G locations, or gasketed for non-hazardous outdoor locations. Housing is cast aluminum. The Beta Corp.

12—CONDENSATE PUMP is vertical, multi-unit type

Having four pumps in a common case and utilizing a common shaft, this unit has been nicknamed the "Sow Pig" because of its eight flanges (four intake, four discharge). This four-pumps-in-one design was developed to save floor space, realize economies of a common

driver, and increase reliability because the use of four pumps on a common shaft requires only a single stuffingbox — and less packing maintenance. Three of the four pumps in each unit are single stage; the fourth is a two-stage pump with external crossover. A vertical electric motor drives the unit, and axial and radial hydraulic balance obtained by double suction impellers and double voluted pump cases. Outer casing of vertically split type with the four sets of inlet and outlet nozzles located in one half to permit removal of rotating element without disturbing the piping. Byron Jackson Pumps, Inc.

13—JUNIOR FIRE TRUCK for industrial plant use

This pint-size fire truck can go anywhere an ordinary lift truck can go, says manufacturer. It is only 5 ft 8 in. high, giving the driver a good view in every direction. An average-size man can reach over it to get whatever equipment he needs. Dry chemical, carbon dioxide and water are provided as extinguishing agents, according to the plant's need, and the truck can carry other fire fighting tools, too. Available accessories include ladders, utility bar, light, hose, portable extinguishers. There is storage room on the truck for fire blankets, boots, masks, coats and first-aid kit. A flashing red light can be mounted on top. It is claimed that the truck and its equipment can be operated by one untrained man, if necessary. Ansul Chemical Co.

14—NETWORK PROTECTOR for extreme operating conditions

The MG-90 is announced as a 3,000-amp network protector operating on voltages of 120/208 and 277/480. Housed in a dust-proof enclosure and protected with Class H insulation, it is designed for long life under extreme operating conditions and features high loading capacity built into a small unit. A minimum current is required to close protector, which operates on stored energy provided by a motor driven mechanism. Relays, fuses, and contacts are easily accessible. According to manufacturer, many safety problems involved in 277/480 v networks are alleviated by use of a 120/208 test voltage on the protector, relays, operating mechanism and auxiliary circuits. Testing can be performed with the usual safety precautions for handling 120/208 voltages. Another advantage is the standardization of replacement parts. General Electric Co.

15—CHLORINATORS feature new metering, controlling principle

Built of corrosion-resistant materials, these V-notch chlorinators cover a feed range from 25 lb per day to 2000 lb per 24 hr. Series A-712 is described as a wide-range model with direct reading dial indication of the feed rate and accuracy given as ±4 per cent over a 20 to 1 range for any V-notch variable-orifice. The Series A-711 Chlorinator serves to provide a rotameter for feed rate indication, to give accuracy over a 10 to 1 range for any one rotameter. Manufacturer states that the V-notch variable-orifice metering and controlling principle utilized provides precise and smooth chlorine feed control over a wide range. Wallace & Tiernan Inc.

16—TINY STEAM TRAP needs almost no maintenance

Slightly larger than a 50-cent coin, the new ⅜ in. Thermodynamic TD Steam Trap is described as well suited for applications such as tracer lines. This trap is reported to withstand water-hammer and corrosive condensate and operate

equally well on light or heavy loads and against back pressures up to 50 per cent of inlet pressure. Practically no maintenance is required for this steam trap, company points out, which has only one operating part, a solid, hardened stainless steel disc. Cap, valve disc and body are of stainless steel. (Thermodynamic Traps also come in ½, ¾ and 1-in. sizes.) Bulletin 257B offers more information. Sarco Co., Inc.

17—UPLIGHT REFLECTOR for high bay mercury lighting

This aluminum uplight reflector is offered to meet the need for greater uplight from the new color corrected mercury vapor lamps used in high bay lighting The reflector measures 24 in. in diameter and utilizes an open top design said to result in 16 to 18 per cent uplight when used with the H1000-C15 and H400-RC1 mercury vapor lamps. This feature serves to maintain proper balance of light between lamp and ceiling, reducing contrast. Manufacturer also claims that

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this fixture improves shielding of the lamp. It is available in socket-reflector or separable-socket (disconnecting) mounting types. Abolite Lighting Div., Jones Metal Products Co.

18—PRESSURE REDUCING VALVE for heat, process steam uses

This air loaded, diaphragm operated, pressure reducing valve, the Class GPK, has a simple design. There are only two moving parts — a metal diaphragm with full valve travel and a hardened stainless steel main valve that seats on a renewable stellited seat ring. An air loader is used instead of a loading spring, and is designed to produce a constant loading force on the diaphragm. The design is said to assure the same control point over full travel. The valve comes in cast iron ¼- to 2-in. sizes, screwed end connections. Inlet pressure is 0 to 250 psi, 450 F. Used with company's Class A air loader or Type P panel mounted loader, the reduced pressure range is 0 to 85 psi; or to 249½ psi with a high pressure loader. More data is in Bulletin 561. Leslie Co.

19—BUSHING DROP OUT provides smooth surface

Announced as a new fitting for company's cable supporting system, this aluminum conduit bushing drop out allows cable to pass easily from cable trough into a conduit and provides a

smooth surface that protects cable insulation. Drop out can be placed anywhere in the trough system by cutting a hole in trough and is attached to trough by bolts. A clamp operated by a hollow head bolt serves to assure that the slotted collar will grip the threaded conduit securely, provide a continuous metallic connection. T. J. Cope, Inc.

20—FLOW ALARM is low cost, vibration-proof unit

Announced as combining low cost with vibration-proof operation, the Ratolarm uses snap-action electrical contacts, hermetically sealed in a glass tube, which are drawn together to set off alarm by passage of a magnetic float extension rod. Switch can be positioned in mounting frame above or below magnet in the float extension rod to signal high or low limits of flow. If placed above magnet, it will set off alarm when increasing flow causes magnet to rise to predetermined position. If placed below, it sets off alarm when flow falls below desired rate or fails. One switch can be set above and another below to give high and low alarms. Multiple alarms may also be incorporated.

Ratolarm is described as insensitive to vibration. It is normally supplied with a dust-proof, plastic-enclosed, plug-in relay. This permits easy inspection of contact points and allows relay to be changed quickly. A fail-safe feature is incorporated to assure a signal if alarm circuit fails. Applicable in water or oil cooling lines for large machines, it may be connected to a light or buzzer or both, or may be used to start a pump, close a valve, shut down system etc. Fischer & Porter Co.

21—TURBINE with all-steel welded rotor

The rotor on this turbine is claimed to be one of the safest on the market. Buckets are of nickel steel, welded to the periphery of the rotor and capped by a steel shroud, also welded. It is explained that should a turbine lose its load, accompanied by governor failure, instead of speeding up to destruction, the buckets would be released from the rotor at the weld, thus removing the steam impingement forces on the rotor. The speed at which the buckets will disengage is several times the maximum operating speed of the turbine, company points out, but well below the rotor's breaking point. It is reported that after 10 years of field tests, no rotors of these turbines have exploded, although on several occasions, whether from accident or otherwise, the turbine load may have been lost or a trip valve failed to function. L. J. Wing Mfg. Co.

22—ELECTRONIC TIMER has independent on-off adjustment

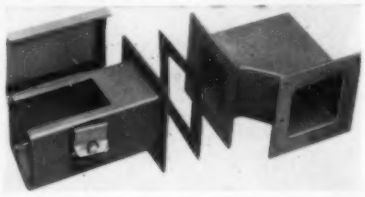
Model 3 CK Electronic Timer is a fully enclosed unit with independently adjustable time ranges for both on and off cycles of 1.5, 3, 6 and 12 sec. It can be converted to a single time-cycle operation by removal of one tube. Fully enclosed terminals are accessible by removal of back cover. Other features announced are: instant starting cold-cathode tubes; tube cut-out during timed-out periods; plug-in relays for easy servicing; eight-amp, single-pole double-throw load contacts for 115-v a-c operation (25 to 400 cycles). Timer is 5 in. high, 4¼ in. wide, 3¾ in. deep. Farmer Electric Products Co., Inc.

23—HYDRAULIC REGULATOR with powerful correcting action

The Powerpack is described as a self-contained hydraulic regulator which develops a powerful correcting action in response to a wide range of signals. Unit is reported especially well suited for relief and reducing valve applications involving lever or butterfly valves. It is also employed for the control of fluid flows and as a remote valve positioner Regulator can be used on liquid level applications, feed water pumps, steam pressure reducing stations for pressure control, flow control, anti-surge governor for blower installations and other places where it is effective because of the high power corrective action which it develops. This power is greatly increased near closed position of valve, it is noted, and gives the extra power needed to shut valves tight or break sticking valves loose. Askania Regulator Co.

24—SECTIONAL RACEWAY with full line of fittings

Oiltight raceway in sizes 2½ by 2½ in. and 4 by 4 in., in lengths to 10 ft, is announced along with a complete line of fittings — elbows, tees, crosses and closure plates — to permit bolting the



raceway together to fit almost any machinery or building requirement. The trough has a hinged cover to permit access to the interior of the full length of each section. Fourteen-gage sheet steel is used throughout except on the welded connection flanges which are 11-gage steel. Finish is gray hammertone enamel over a phosphatized surface. The cover is gasketed with sponge Neoprene rubber and a Neoprene gasket is placed between each section to make the assembled raceway oil, dust and water tight. Hoffman Engineering Corp.

25—BURNER THROAT TILE permits gas flame stability

This new design of rifled burner throat tile is claimed to permit extreme flame stability over a wide range of firing conditions and to give satisfactory performance even when excessive combustion air supply is present. With the rifling directionally opposed to air rotation, the new tile develops low velocity eddy currents to provide a series of continuous and positive pilots for the main body of the combustible mixture. The new rifled tile is said to enable reduction of gas flow to the minimum setting and increase windbox pressure to maximum value without loss of ignition. Peabody Engineering Corp.

26—PYROMETER measures hot gases in difficult situations

For situations in which gas temperatures and surroundings change constantly, the Land Suction Pyrometer is designed to measure heated gas from 0 to 2900 F. It is expected to find usage in water tube boiler furnaces; uptakes and regenerators of open hearth furnaces; glass tanks. Suitable indicating and recording instruments can be used in conjunction with this pyrometer, and the company can provide complete systems. Three models are offered using

Bailey Recorder for receiving pneumatic and electric signals.

Measured Variables
% combustibles
combustion
conductivity
density
differential
draft
flow
liquid level
% oxygen
pH
position
pressure
ratio
smoke density
specific gravity
speed
temperature
vacuum

Pick any four, plug in, and record

Here is a receiver recorder, custom-built *by you* to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

PSB-1

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

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METER COMPANY
1040 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

BAILEY METERS
Controls for
TEMPERATURE
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FLOW · LEVEL
RATIO · DENSITY

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POWER
SPECIALISTS!
KULJIAN HAS DESIGNED, ENGINEERED, AND SUPERVISED CONSTRUCTION OF POWER PLANTS THE WORLD OVER . . . WITH TOTAL ELECTRIC GENERATING CAPACITY EXCEEDING —
2,000,000 KILOWATTS!

Vast power projects throughout the world—more than seventy in all—attest to The Kuljian Corporation's reputation as SPECIALISTS IN THE POWER FIELD. These power plants, with capacities ranging from 2,500 to 240,000 KW, represent a total investment of over half a billion dollars.

No matter what type of power project you are planning . . . be it steam, hydro, or diesel . . . Kuljian's wealth of practical experience, backed by a complete staff of internationally recognized engineers, can serve you quickly, economically, and efficiently to meet your specific requirements.

Next time *you* need outside help, why not contact a Kuljian engineer for preliminary consultation. He will be glad to provide the help you need, anytime . . . anywhere.

ACTUAL ON-THE-JOB REPORTS are continually received at Kuljian headquarters. From these reports, easy to read case histories are developed into articles that are published by editors of leading magazines.

If you are interested in knowing more about us . . . how we work, what we have done for others . . . your request for literature will be most welcome.

The **Kuljian** *Corporation*

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BRANCH OFFICES THROUGHOUT THE WORLD

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platinum and platinum rhodium sensing elements, each designed for a particular use and temperature range.

In operation, the device forces hot gases at high velocity past thermocouple temperature-sensing elements to increase convective heat transfer from the gas. Concentric shields protect these elements from external influences. The main unit consists of a water-cooled stainless steel jacket, 6 ft long. (Company will supply any length from 4 to 12 ft.) A platinum thermocouple with 5 ft of spare wire in a reel box is also part of this suction pyrometer. Fielden Instrument Div., Robertshaw-Fulton Controls Co.

27—CIRCUIT BREAKER is 800-amp, molded case unit

This 800-amp M-frame circuit breaker, the type ET, is announced as the first molded case circuit breaker to be approved by Underwriters' Laboratories for operation at this continuous current rating. No larger than company's L-frame breaker rated at 600 amp, this new 800-amp breaker can be used in panelboards, power panels, switchboards, motor controls, bus duct plugs and individual enclosures. It offers optional pressure connectors for either double or triple cable connections per phase within the circuit breaker case. Double 300 to 500 mcm cable connectors are available for breakers rated 600 and 700 amp. Triple 300 to 400 mcm or special double 600 to 750 mcm connectors are available on breakers rated 800 amp.

The 3-in. pole-center design dimensions are designed to permit easy accessibility for front cable or rear bus and stud connections. The new 800-amp breaker comes with interchangeable trip units providing continuous 600, 700- or 800-amp ratings in two- or three-pole construction for 250-v d-c and 600-v a-c service. Interrupting ratings are 25,000 amp at 600 v a-c, 35,000 amp at 480 v, 50,000 amp at 240 v; and 20,000 amp at 250 v d-c. I-T-E Circuit Breaker Co.

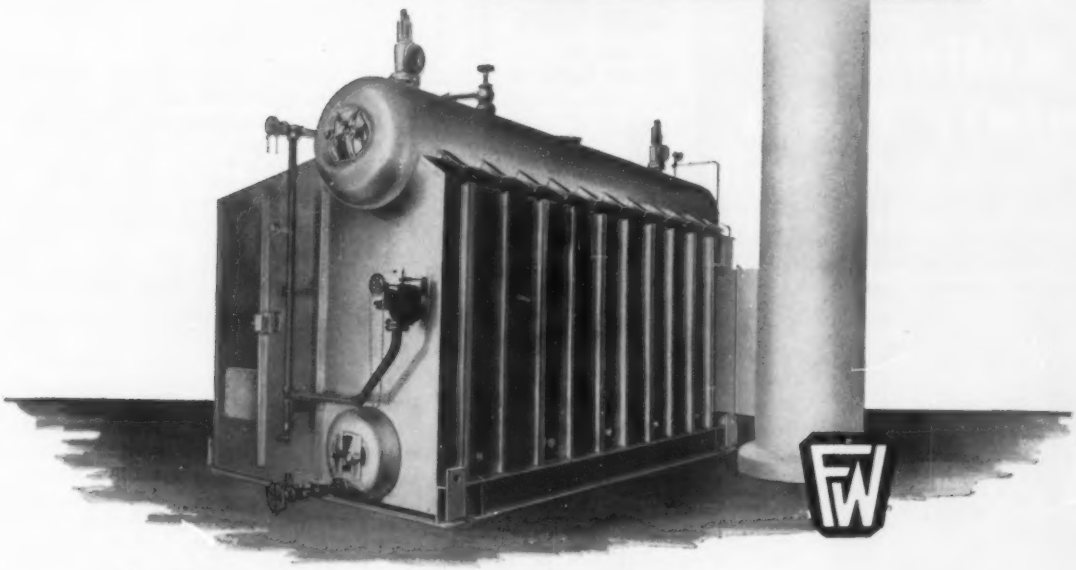
Reader Service Cards on pages 121–122 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

28—STUD DRIVER is low cost, powder actuated fastening tool

Biggest advantages claimed for the Mighty-Mite Model 456 Stud Driver are low initial cost — less than $35.00 — and easy adaptability to jobs calling for low volume fastening output. It is constructed of three simple parts and weighs only 3¾ lb. After a stud with "Power Guide" disc attached has been placed in the barrel, the operator inserts a 22-caliber power load. When he twists and depresses the tool against the work surface, the firing pin is exposed at the top. A light hammer-blow against the pin fires the tool. Manufacturer says an operator can drive studs at better than one-per-minute rate.

Power loads come in different strength powder charges. Built-in safety is a feature stressed for the Mighty-Mite. It

CUT STEAM-PLANT INSTALLATION AND MAINTENANCE COSTS

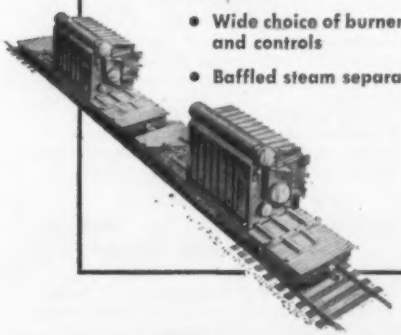


. . . with the NEW Foster Wheeler

PACKAGED STEAM GENERATOR

CONSTRUCTION FEATURES

- 36″ steam drum and 24″ water drum
- Staggered boiler tube arrangements
- Closely spaced waterwall tubes
- Water cooled target wall
- No headers—Low circulation loss
- Light, highly efficient refractory and insulation
- Wide choice of burners and controls
- Baffled steam separator



HERE IS a compact, space-saving steam generator that is completely factory assembled and shipped to you ready to set on a simple, low-cost foundation—ready for your fuel, steam and electric connections. There is only one outlet to the stack, and this has a simple, flanged connection as shown above. Extremely compact design permits access to boiler rooms through average building openings.

Low refractory maintenance is assured by the use of closely-spaced waterwall tubes and water-cooled target wall. The boiler interior is easily accessible for cleaning through a large access door in the rear furnace wall, and dusting ports are provided along the boiler bank side at intervals of not more than 42″. Soot blowers can be furnished as original equipment or installed later.

Available in capacities from 10,000 to 50,000 lb/hr, the *new* FW Packaged Steam Generator represents the last word in modern steam plant design. For complete details, send for Bulletin PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

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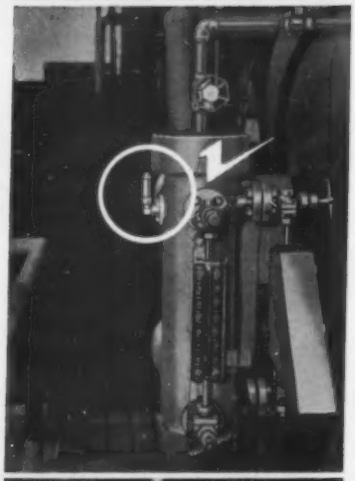
For more data circle 541 on Post Card

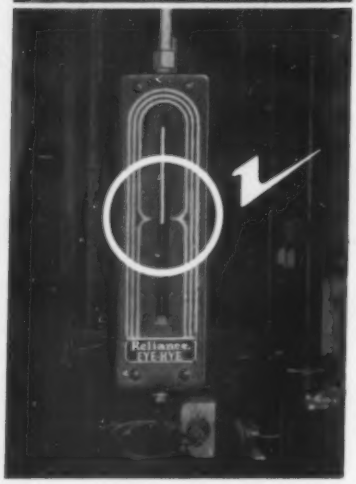
Two watch dogs... twice as good as one...

Let the Reliance Safety Team give you a double check on boiler water levels

Sound Check
Alarm
Water Column

Sight Check
EYE-HYE
Remote Gage





This team works for thousands of plants like yours. It double checks boiler water levels—helps you achieve more efficient operation, lower power cost, greater safety. The sensitive float-operated mechanism in the Alarm Water Column sounds a last-resort warning (see whistle) when water approaches low or high danger points. But for minute-by-minute scanning by operators, EYE-HYE beams its bright picture of true water level condition from a convenient eye-level position. It's the original remote reading gage — all-hydrostatic, simple, sure.

Now... alarms on pressures to 2500 lbs.!

Steam whistles are available on Reliance water columns up to 900 psi only. But with the Reliance Levalarm EA17 you can have vibratory horns or warning lights or both, to assist EYE-HYE in water level "watch dog" service. It pays you to have the Reliance Safety Team for adequate boiler water level supervision. Write for details — or ask your Reliance Representative.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

The name that introduced safety water columns.... in 1884

Reliance®

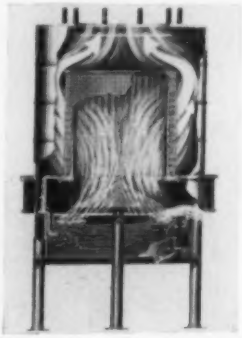
BOILER SAFETY DEVICES

For more data circle 542 on Post Card

must be held vertical to the work surface before it will fire and must be twisted and depressed against the work before it will operate. Some of the fastening jobs this tool is suggested for include: duct suspensions; electric motors to concrete; lighting fixtures to concrete and steel; pipe hangers to concrete, steel and brick; control and switch boxes to concrete, steel, brick. Remington Arms Co., Inc.

29—OIL BATH FILTER for compressors, blowers, engines

The LPD Oil Bath Air Filter combines efficiency with extremely low pressure loss, it is announced, achieving low-pressure-drop operation without moving parts or outside energy supply. Air is



drawn in under a weather hood set low on unit and directed through an air-flow regulator tube to an oil control pan. Here it picks up droplets of oil which are carried up through a diffuser cone where air and oil are thoroughly mixed and air is scrubbed. Air then passes through cylindrical filtration element where dirt particles and oil droplets are removed, permitting only oil-free air to flow to engine, blower or compressor. Oil and dirt flow down inside filtration element and through oil-return pipes to sump where dirt settles out. Clean oil is metered from top of reservoir into oil control pan. Air-Maze Corp.

30—METAL POLISH in paste form, gives mirror-like finish

Ge-Halin, developed in Germany, is announced for polishing aluminum, copper, brass, silver, chrome, tin, bronze, gold and stainless steel. In paste form, this product is said to polish aluminum like chrome and retard the pitting action. According to manufacturer, the cleaning powder in the formulation is capable of removing layers of grime and tarnish quickly, without scratching, restoring to a high lustre non-ferrous metals neglected by virtue of lack of an effective cleansing agent. Ge-Halin is said to remove rust and polish chrome in one operation. Haldar Sales & Co.

31—PANELBOARD for heavy-duty power distribution

Incorporating rigidly mounted fusible switch units of the quick-make, quick-break type, the Type QMR Panelboard is designed for 600-v a-c maximum service, two- or three-wire, single phase, and three- or four-wire three-phase applications. Company says it can be safely operated in systems having short-circuit capacities up to 100,000 amp RMS asy-

Hall Industrial Water Report

VOLUME 4 AUGUST 1956 NUMBER 4

Scale or Sludge Deposits Can Crop Up Most Anywhere Water is Used

When they do, the water detective must find the cause and the cure. Sometimes the problem is run-of-mine. More often, however, it brings into play his skill and experience as a specialist in dealing with water.

Cold Niagara Revealed as Offender

As winter cold deepened, a chemical manufacturing plant on the Niagara River, a Hall client for many years, suddenly experienced a hard glassy deposit in the plant intake and distribution system. Pumps had to be removed from service for cleaning. Mechanical cleaning had no effect, but when the pumps were heated with steam the deposit softened and washed out.

G. H. Smith and R. E. Elliott, Hall engineers in the Buffalo office, found that the Niagara River water at the plant intake showed greater than normal values for calcium, alkalinity and pH, indicating contamination by an alkaline calcium-bearing material. However, this information did not explain the fact that calcium carbonate was being deposited in the cold sections of the system rather than at points where the water was being heated.

Elliott called J. P. Kleber at the home office in Pittsburgh for an opinion. From past experience, Kleber had the answer immediately. Hexahydrate of calcium carbonate! —a quite uncommon material. Temperatures below 40F plus some free hydroxide alkalinity in Niagara River water had precipitated this compound. When the temperature was elevated, the material lost its water of hydration and left a relatively soft calcium carbonate mud.

How to prevent the deposit? Nothing could be done about the contamination or the winter temperature of the incoming water. While treatment of this water with 5 ppm of Calgon® would keep the scale from forming, in-plant changes appeared to be less costly than chemical conditioning. Well-pleased with the diagnosis and suggestions, the plant went ahead with these changes.

Desuperheater Develops Deposit

At a lumber plant in Oregon a low-pressure turbine using desuperheated steam suffered a substantial decrease in capacity. Inspection of the desuperheater and the steam line beyond it revealed the presence of deposits an inch thick.

R. T. Manion, Hall field engineer in Portland, uncovered the fact that during the night there was insufficient condensate for desuperheating, so raw water was being used to supplement it. Evaporation of this raw water deposited the solids it contained in the desuperheater, steam lines and turbine.

Further investigation produced a practical answer to the problem. During the day there was more condensate than required for desuperheating, so Manion recommended storing the excess for use at night. Now the plant has sufficient condensate for desuperheating at all times. As a result, turbine capacity remains constant and the former difficulties with valves, strainers and traps are no longer experienced. A recent inspection of the desuperheater showed it to be clean.

Midwest Power Co-operative Eliminates Manual Cleaning Of Preheater Trays

Hand chipping of hard, white scale from their evaporator preheater trays was a time-consuming monthly task at a midwest power co-operative. J. F. Nelson, Hall field engineer in Kansas City, suggested changes in points of chemical feed ahead of the preheater in order to obtain good mixing of the conditioning chemicals before the water reached the preheater. He further recommended the feeding of 5 ppm of Hagan Dispersive®.

Since the start of dispersive feed a 30 percent increase in evaporator capacity has been noted because of cleaner heat transfer surfaces. Also when the preheater trays were cleaned after three months' operation the deposit found was so soft it could be removed with the fingers. Further changes have been recommended which should result in even greater improvement in conditions.

Hospital Reports Condition Of Boilers Excellent

When a hospital on Long Island, New York, decided to increase steam generating capacity, Hall Laboratories was invited to provide water conditioning service for the expanded boiler plant.

Hall field engineer R. A. Beardsley found that the old boilers contained a considerable amount of scale difficult to remove by mechanical cleaning even though the make-up water had been zeolite softened and phosphate and soda ash had been used for internal conditioning. Serious tube difficulties had been averted simply because the boilers had been operated at very low ratings.

After three years of cooperative effort with Beardsley, the Chief Engineer at the Hospital reports, "The new boilers are free of scale and corrosion. The scale has been removed from the old boilers and it is now possible to operate during the off-heating season with only one boiler at greatly increased fuel efficiency."

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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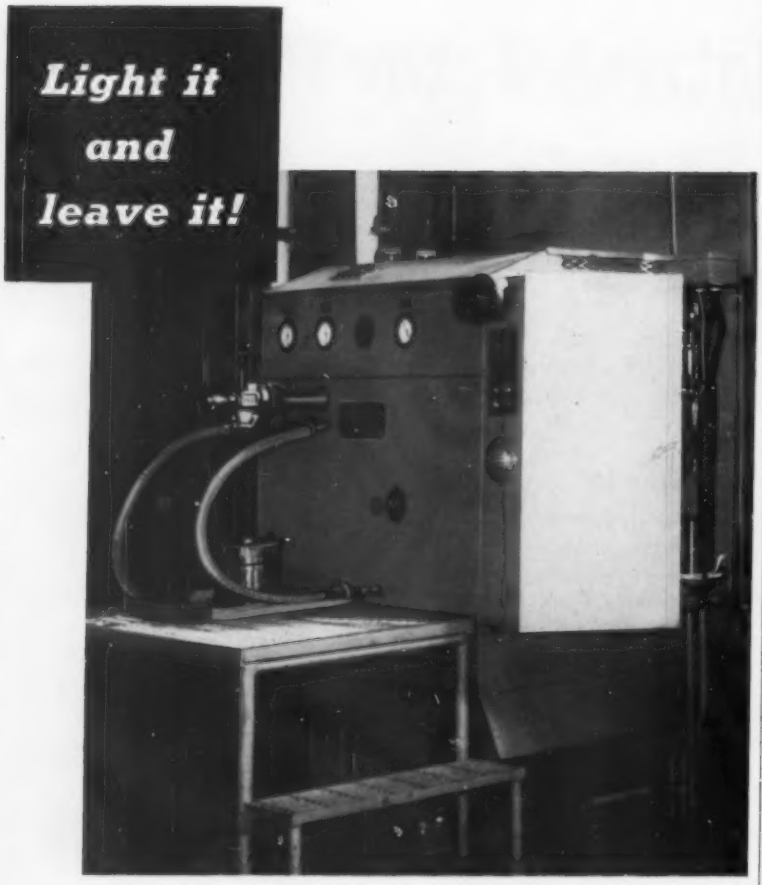

The Peabody PK-54...

Industry's Most Dependable Automatic Burner

MORE THAN 400 UNITS already installed prove that the Peabody PK-54 is the most advanced, safest and most dependable automatic burner in industry.

Peabody's pioneering in safety engineering has promoted such design improvements as "guillotine" solenoid valves; the *one-second flame failure drop out;* the *electronic modulating control relay* and the *tube-over-tube dripless oil gun.* These advanced components are included as standard in the PK-54 burner. It is years ahead of all other units!

Completely packaged, factory-fired and tested for each installation, the PK-54, with fully automatic, semi-automatic or manual control, is available for firing gas or oil, singly or in combination, to produce up to 45,000 lbs. of steam per hour.

Write *today* for complete information.

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metrical when current-limiting fuses are used. Fusible switching devices are individually enclosed in a protective steel compartment. An interlocked cover can be opened only when its handle is in the "off" position. Units are of modular construction for interchangeability, and can be provided in ratings of 30 to 200 amp, two- and three-pole construction. General Electric Co.

32—VISE LACER is designed for small hooks

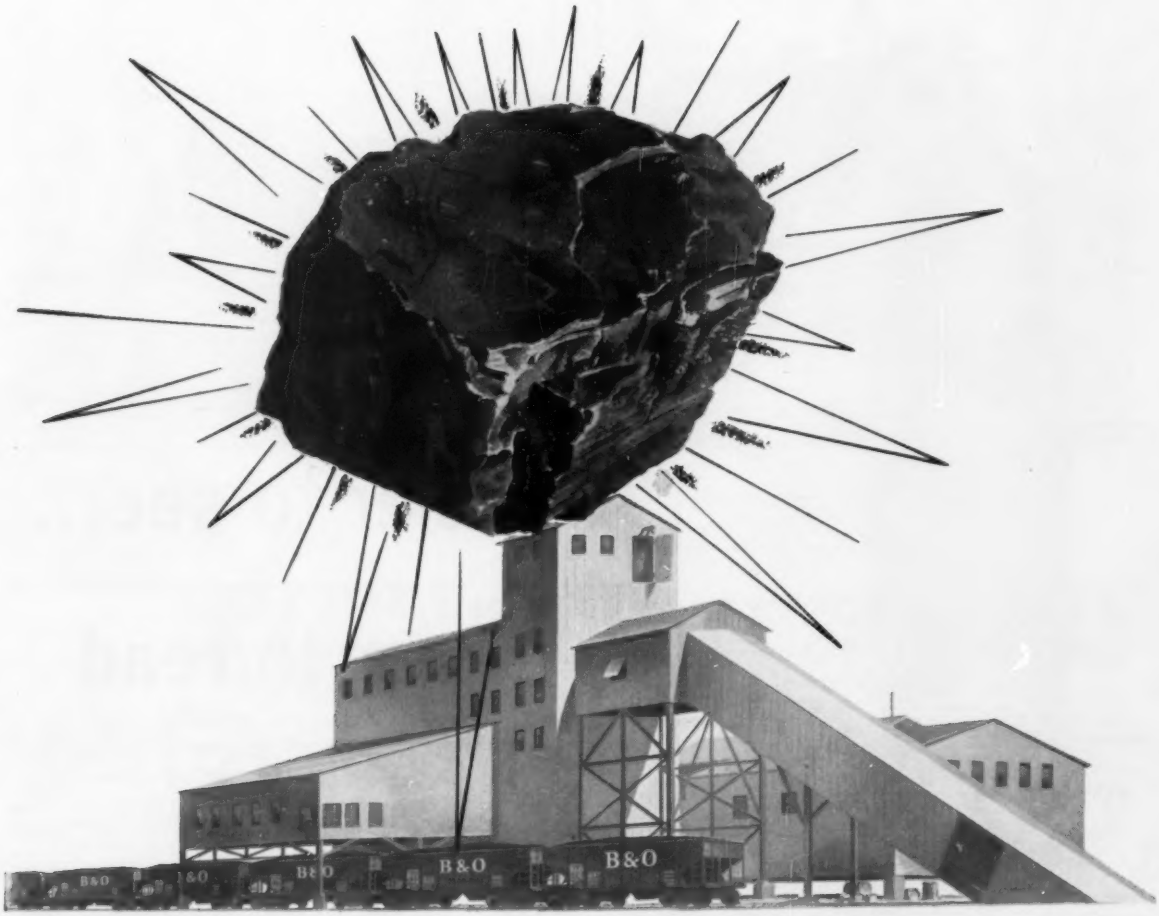
The No. 1-6 in. Vise Lacer, designed for belt hooks used to lace belts from 0.060 to 0.156 in. thick, can be used in any standard vise 4 in. or larger. Hook retainer on the vise lacer has 50 slots to

accommodate standard 50-hook card of the No. 1, 1-A and 1-D hooks. The No. 1 hook is for belts 0.126 to 0.156 in. thick, the 1-A for belts 0.086 to 0.125 in. thick and the 1-D for belts 0.060 to 0.085 in. thick. Lacing wide belts with these hooks previously required a special hook adapter for regular belt lacers. The new vise lacer is the first one produced by this company to accommodate the full 50-hook card. According to company, it will make for easier servicing of belts on such machines as those with a 15¼-in. belt 0.070 in. thick and those with a 4-in. belt 0.125 in. thick. This lacer sells for less than $10. Clipper Belt Lacer Co.

33—AIR BREAKER for metal-clad switchgear

Model 50-DH-50-A Circuit Breaker, rated 4.16 kv, 50,000 kva, is announced for use in indoor and outdoor metal-clad switchgear. Lighter and smaller than its predecessor, breaker can be modified at factory to fit into older housings. It has main contacts of self-aligning multiple-line butt type. Separation of these contacts transfers current to arcing contacts whose erosion is minimized by inlays of silver tungsten. A lighter-weight hinge-type arc chute with improved arc interrupting ability is used.

By removing one bolt, chute can be tilted back for inspection and maintaining of contacts. Withdrawing a hinged pin permits removal of complete arc chute. All parts are accessible for inspection. Entire contact for each single-pole unit is mounted in a U-shaped fire- and shock-resistant molded base support. This permits changing one pole without disturbing setting of other two. Faster interruption of low magnetizing currents is accomplished by a new puffer that speeds movement of the arc. Westinghouse Electric Corp.



Energy Unlimited!

BILLIONS OF TONS OF LATENT POWER... READY TO MEET THE FUTURE'S NEEDS

➔ Bituminous coal offers the nation a priceless commodity —a virtually untapped source of low-cost power. The B&O serves areas with proved *usable* reserves containing billions of tons of this *fuel with a future*, convenient to industry's heaviest concentration.

As population grows and living standards soar, the added energy requirements can easily be met by B&O Bituminous. In addition, its modern mining and utilization will assure greatest efficiency at stable, low cost. *Ask our man!*

LET OUR COAL TRAFFIC REPRESENTATIVE HELP YOU!
He will gladly suggest the perfect constant-low-cost Bituminous coal for your particular needs.
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boiler water levels now easier to **see**... easier to **read**

Whatever the boiler pressure, high or low, YARWAY Remote Indicators give accurate, instant, eye level boiler water level readings at any convenient plant location.

Boiler Code Case No. 1155* says in part, "... two independent remote level indicators of the compensated manometric type may be used instead of one of two required gage glasses for boiler drum water level indication in the case of power boilers with all drum safety valves set at or above 900 psi ..."

YARWAY Remote Liquid Level Indicators fill the bill—and feature a "wide vision" face that makes reading easier from any angle.

Accurate—because indicator is actuated by the boiler water itself—by the pressure differential between a constant head and the varying head of water in the boiler drum.

Also use YARWAY Remote Indicators on heaters of various types.

For full description, write for YARWAY Bulletin WG-1824.

*Write for free reprint of case description.

Yarway Remote Hi-Lo Alarm Signals—lights or horns—can be used with Yarway Remote Liquid Level Indicator and placed at any location in the plant.

YARNALL-WARING COMPANY

100 Mermaid Avenue, Philadelphia 18, Penna.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY REMOTE LIQUID LEVEL INDICATORS

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Typical Parisian street scene near CIGRE meeting, photographed by Editor Kramer

CIGRE MEETING IN PARIS REPORTS WORLD DEVELOPMENTS IN ELECTRIC POWER SYSTEMS

In this report, direct from Paris, covering the 1956 CIGRE Convention, our traveling editors describe some of the most important developments in the generation, transmission and distribution of electric power throughout the world and show the direction in which further development in these fields is proceeding in various countries

By RICHARD H. MORRIS
Editorial Director
and
ANDREW W. KRAMER
Editor
POWER ENGINEERING

CIGRE members arriving for their 1956 Convention at the Foundation Berthelot

IT IS SOMEWHAT of an ordeal for two American editors to have to take time out from the numerous distractions afforded by Paris in the springtime to write a report of even so valuable a technical conference as the 1956 Convention of CIGRE being held here these first ten days of June. The Conference, however, is extremely interesting, both from a technical and international standpoint, and except for the distractions mentioned, the task of preparing a report on the meeting involves no serious hardship because everything concerning the convention is well organized.

For those in the United States not familiar with CIGRE, (pronounced see-gray) a brief description may be helpful. CIGRE are the initial letters of "Conference Internationale des Grand Reseaux Electriques." In English it is the International Conference on Large Electric Systems. This organization was founded in March 1921 under the aegis of the International Electrotechnical Commission. It operates with the support and assistance of all the large inter-

national electrotechnical organizations and includes members from all countries. It is not only the oldest of all international electrotechnical organizations (except the IEC) but is also by far the largest, having 2000 permanent members and 2560 corresponding members located all over the globe. Its biennial meetings have become the Mecca of electrical engineers from all over the world. At this present meeting we have an attendance of some 2000 members.

The 2000 permanent members from 41 different countries give the organization a stable foundation and a solid financial basis. Any electrical engineer, any industrial or scientific society, any body devoting its activity to high tension electrical systems may become a member.

This 1956 Convention being held here in Paris from May 30 to June 9 is the 16th since the organization was established in 1921. Headquarters are at the Foundation Berthelot at 28 bis, rue Saint-Dominique, close to the National Assembly and many other famous places of interest.

All meetings are well organized: Thus no time is lost in presenting the technical papers discussed. At this meeting a total of 117 papers are being presented, all of which are published in both English and French. Every delegate who registered before April 1 received a complete set of these papers well in advance of the meeting, so as to give him an opportunity to read those in which he may be specially interested. Thus, those wishing to enter the formal discussions are assumed to be thoroughly familiar with the papers themselves and so the technical sessions are devoted *only* to discussion of the papers — not to their presentation. As a general rule, because of the large number of discussors, each discussor is limited to six minutes for the presentation of his discussion. These discussions are delivered either in French or in English, but immediately after a discussion has been presented in either of these languages, an interpreter re-presents the discussion in the alternative language.

In addition to these successive interpretations, members are also provided with very small transistorized radio receivers and headsets by means of which they can listen to a simultaneous interpretation while a discussion is being presented. This little receiver is a marvel of compactness, approximately 7 in. long, 1½ in. wide and 1 in. thick. It is provided with a sliding switch with 4 positions, for tuning in on various frequencies. When in use the listener merely clips the receiver to the breast pocket and sets the switch to whatever language he understands. Reception is remarkably clear and free from noise. The receivers contain a germanium diode serving as a detector and a junction-transistor amplifier. A small radio transmitter back of the stage broadcasts the discussion.

Another interesting and very useful device used at the sessions is an illuminated translucent horizontal panel at one side of the speakers platform. As each delegate comes to the microphone to speak, an attendant places large individual block letters in front of the illuminated panel, spelling out the delegate's name, and the code number of the country he represents. Each of the 48 countries represented at this meeting has a code number. By this method one is at all times aware of who is speaking and his country.

The American delegation attending this conference is the largest group from the United States ever to attend a CIGRE meeting in Paris.

The facilities at the Foundation Berthelot where this convention is being held are excellent. There is a large auditorium as well as a large meeting room. The latter is used only when there are simultaneous sessions. At any time, however, there have been only two simultaneous sessions because an effort has been made at this meeting to have fewer simultaneous sessions than at previous CIGRE conventions in order to enable every delegate to attend all those which are of interest to him without being obliged to choose between them. Simultaneous meetings are being held on three days only. These simultaneous sessions involved:

Alternators — Cables
Transformers — Towers
Circuit Breakers — Overhead Lines

Each technical session was under the direction of a Group President, usually a distinguished member of one of the foreign delegations, and each group had what was known as a Special Reporter. It was the latter's function to summarize briefly the contents of the various papers presented at that session and to impose questions concerning the papers as subjects for detailed discussion.

Organization of the Technical Sessions: The technical reports together with the discussion of these reports were broadly grouped into four major categories, referred to as *Sections*.

The first section dealt with the Generation, Transformation and Interruption of Current. Section two comprised reports devoted to the Construction, Insulation and Maintenance of Overhead and Underground Lines. Under this section were four groups of papers, i. e., High Voltage Cables; Towers and Tower Foundations; Overhead Lines and Vibrations; and Insulators.

Group three papers discussed the Operation, Protection, and Interconnection of Systems. These papers were in two groups as follows: Protection and Relaying; System Stability, Load and Frequency Control.

The fourth group of papers dealt with Extra High Voltages and with Direct Current Transmission at Extra High Voltages.

Generation,

ALTERNATORS: In his special report on the papers on alternators, A. Wust of Belgium briefly reviewed the present status of alternating current generators. He pointed out that although efforts made in recent years with a view to perfecting electrical machinery, and in particular alternators, have led to remarkable advances in the construction and behavior of generators, the continued need for machines of greater and greater capacity makes further improvement increasingly difficult.

As Dr. Wust explained, it has been possible to achieve the present stage of alternator development only through a better understanding of the fundamental principles governing the functioning of the machine, on the one hand, and of the behavior of the materials used in their construction on the other hand. The group of papers presented at this session show clearly that despite their high stage of development, alternators still remain one of the foremost problems, both for makers of heavy equipment and for producers of electric energy.

In view of the increasing demand for power throughout the world it becomes necessary to install generators of constantly increasing capacity, especially in thermal stations, whose characteristics must meet operating conditions substantially more complicated than in the past.

The papers at this session could be broadly divided according to three categories. First was a group comprising papers devoted to new techniques in the construction of generators. In this group was an excellent résumé of American Developments in Generator Cooling by W. L. Ringland of Allis-Chalmers, C. E. Kilbourne of General Electric and L. A. Kilgore of Westinghouse. These authors discussed the most recent practice in inner cooling of generator conductors, both by means of high pressure hydrogen and by the use of liquids as the heat transfer medium. As pointed out by the authors, these methods were developed in America to eliminate the thermal drop across the insulation of large generators and at the same time to remove to a large extent the temperature limitation which formerly existed. These new methods extend the maximum kva rating possible in two-pole generators. The largest maximum ratings so far are about 320,000 kva, but still larger machines are contemplated. For smaller ratings, the new methods offer savings in weight and size, and lower short circuit currents.

This paper by the Americans evoked considerable discussion by the delegates from England and France, particularly regarding the use of these methods of generator

cooling on the 3000-rpm machines used throughout Europe on the 50 cycle systems.

As explained by W. N. Kilner of Metropolitan-Vickers, the British have followed general U. S. practice in the design of alternators but because of the somewhat lower ratings used up to the present, have not had to use inner cooling even on the largest English units. Ratings are now reaching the point, however, where inner cooling becomes necessary. Anticipating this, Mr. Kilner stated that they have been studying American practice and have come to the conclusion that liquid cooling is the most attractive. Indeed, he felt that liquid cooling was so superior to gas cooling that he wondered why so many American machines still continued to use gas cooling instead of liquid cooling.

Mr. Kilner showed slides of experimental coils made by his company designed for liquid cooling. The end connections of these coils comprised an assembly of copper ferrules and stainless steel clamping nipples for attaching the plastic tubes through which the liquid coolant entered and left the hollow conductors. Mr. Kilner admitted that these were experimental units and that they had never been used in practice. He felt confident, however, that they would give no trouble on an actual machine and finally again emphasized the fact that the heat transfer properties of liquids are so superior to those of gas that the use of liquids was almost imperative.

Dr. Wolfhugel discussed the difference in speed between the American machines and the 3000-rpm units which are used in Europe. For a given rating, the 3000-rpm units are naturally somewhat larger in physical dimensions and weight, a question also commented on by L. W. James of the British Central Electricity authority. He felt that the problem of the design of inner cooled generators for 3000-rpm service was essentially the same as for 3600-rpm service. With respect to physical dimensions and weight, Mr. James indicated that there were severe limitations in England because of their lighter railroad equipment. If for no other reason, the transport problem would make it necessary for them to go to liquid cooling for their future large alternators.

In summing up these discussions on inner cooling of generators, M. Belfils of France who was president of this session said that he fully realized the importance of liquid cooling for very large machines and that it had many advantages. Regarding transport, however, he explained that in France they had other means of transport than the railroads. They have an excellent system of waterways and canals. In some cases the electrical manufacturing plants are only a few kilometers from these waterways.

General view of one of the technical sessions at CIGRE meeting in Paris. The American delegation consisted of 45 men and 18 women, from all parts of the U. S.

Each speaker was identified by name, with code number for his country. Only discussion of papers was presented at the meeting; all papers were pre-distributed

Generator Cooling Using Refrigeration: Quite a different aspect of generator cooling was described in a paper by A. Mandi, J. Urbanek and L. Heller, all of Hungary. This also described the application of cooling by means of liquids to various types of rotors, and in the second part, they discussed the reduction of the basic temperature of the cooling fluid by a refrigerating unit inserted at some point in the cooling fluid system.

Water-cooling of synchronous machines, the authors pointed out, had a fairly long history in Hungary. Water cooling of the 4-pole rotors of the 3 — 2 phase converters used in the 50-cps Kando-locomotives have been in use for 25 years with satisfactory results. The favorable operating record of these machines led them to a study of water cooling for the rotors of two-pole turbo-alternators. The tests which the authors described involved an experimental rotor using copper cooling coils either in direct contact with the insulated conductor in the rotor slot, or installed in separate slots between the conductor slots.

In the second part of their paper, the authors considered the use of several different schemes for cooling the heat transfer fluid by means of refrigeration. The most attractive of the schemes proposed involved the use of a steam ejector refrigerating machine in the cooling circuit. In this case steam is bled from an intermediate turbine stage, and the condenser of the main turbine is

Editorial Director R. H. Morris (second from left) discusses a paper with European engineers attending the meetings

used as the condenser of the cooling machine. This solution is not only the most efficient, the simplest and the cheapest, but it has the further merit of inserting the supplementary cooling directly in the thermal cycle of the station. A diagram of the arrangement is shown in Fig. 1.

Alternators for the Tidal Power Plant of the Rance: A paper that brought forth interesting discussion at the second session on alternators was one by R. Gibrat and L. Kammerlocker of the French delegation, on the design of the generators for the tidal power project on the Rance which has been under consideration for nearly fourteen years. The extremely low hydraulic heads, the necessity for reversible operation (as generators or as motors) the need for selfstarting and many other unique features of this project make the design of the generators a task of unusual difficulty. The machines are of a type known as the upstream bulb type and operate by direct drive without gearing.

Insulation of Large Alternators: The second group of papers presented at the alternator sessions was devoted to the insulation of large machines. These papers dealt both with current research work on test methods for verifying the quality of a winding and its behavior over a period.

Among the methods for checking the high-voltage winding, consideration has been given in France to the variation over a period of time of the rise in temperature of the stator copper. Measurements are made on the machines while they are in service. This method is now being used systematically by Electricité de France, with entire satisfaction according to the authors of the report describing this method.

In the discussion of this technique, it was questioned whether this fluctuation in temperature is a criterion of the condition of the insulation, and also whether this measurement has significance in itself or whether it should be considered in conjunction with other measurements or tests.

Other non-destructive methods of investigation of insulation effectiveness involve:

a. Measurement of the loss angle and its variations
b. Direct measurement of ionization
c. High and low voltage d-c tests
d. Tests under surges.

In a report on the research work on the insulation of large synchronous machines, J. Laverlocher described briefly the astonishing variety and quality of the work done at the research center of Electricité de France. This involved details of all of the methods listed above together with various data concerning the results obtained. Several methods of measuring ionization were described.

Dr. Hess of Brown Boveri in discussing these various methods pointed out the danger of making only a few measurements of insulation resistance. He showed a slide giving values of a large number of measurements of various types of insulation which brought out his argument. They varied over extremely wide ranges and often for no obvious reason.

Dr. Stromberg of the Swedish delegation also stressed the fact that when winding shows a changed condition in its insulation resistance, it may be due only to a failure in some small part of the insulation, not necessarily deterioration of the insulation of the machine as a whole.

Dr. P. J. Nowacki (Poland) felt that no method exists now for deducing everything from ionization measurements as some of the papers seemed to imply. The threshold ionization voltage is, however, an index of the state of the insulation. He thought that a more effective measure of insulation effectiveness could be deduced from the ratio of the ionization current to the capacity current.

Measurements on Alternators Under Operating Conditions: The final group of papers discussed at the sessions on alternators was concerned with methods of making measurements on alternators under operating conditions.

Like the problem of insulation measurements, this also is a complex area of electrical engineering and while much has been learned about this area in recent years, many

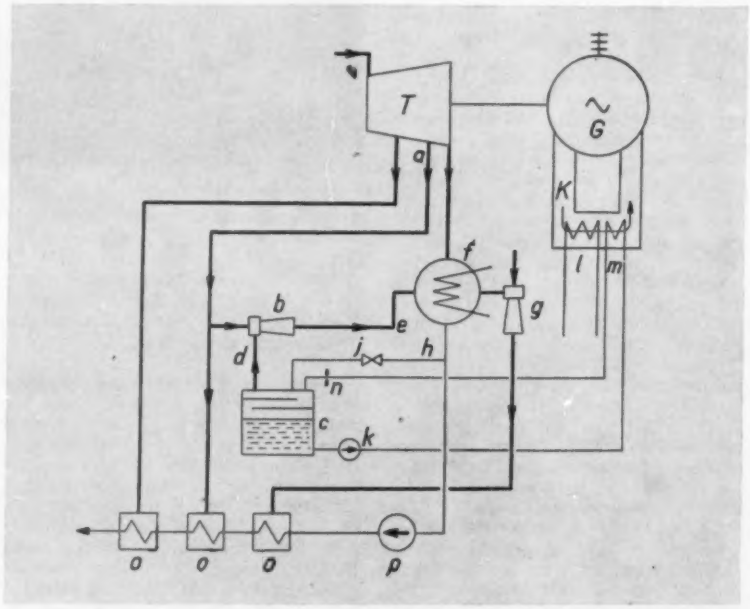


Fig. 1. Generator cooling using refrigeration. With method shown here the condenser of the main turbine is also used as the condenser of the cooling machine
G, generator; K, circulating air; T, steam turbine; a, bleed point; b, steam ejector; c, evaporator; d, suction line of the steam ejector; e, counterflow line of the steam ejector; f, steam turbine condenser; g, vacuum pump; h, condensed water line; j, regulating valve; k, circulating pump; l, cooling system; m, supplementary cooling system; n, reducing disk; o, extraction feedwater heater; p, turbine condensate pump

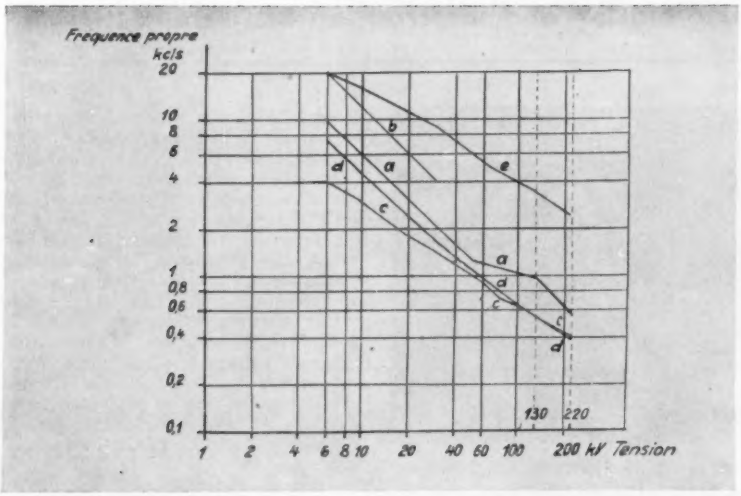


Fig. 2. Charts showing wide range in proposed standards for natural frequency of re-striking voltage. (a) and (b) Swedish, (c) Swiss, (d) French, (e) English

differences of opinion prevail concerning the practical effectiveness of this class of measurement. A report by E. B. Powell, for example, described a stroboscopic method of measuring phase angle. This method is comparable to having a pilot alternator keyed on the shaft of the main alternator. There were questions among the delegates as to the relative efficiency of the two methods. Can the data produced by these two methods easily be transmitted to distant points?

Another report, No. 110, by D. T. Bath of the General Electric Co. in England, dealt with the use of an arithmetical electronic meter for measuring the slowing down of a machine with a view of determining losses by the deceleration method. This rate of change is commonly designated $\frac{dN}{dt}$ where N is the rotational speed in rpm and t is the time in seconds. Rate of change in speed multiplied by the moment of inertia of the rotating mass, multiplied by the appropriate conversion factor, yields the losses of the alternator corresponding to the conditions of the test. There seemed to be some question as to whether this interesting method could be generalized.

Other reports dealt with the measurement of temperatures of alternators. While it appears that rotor temperatures can be judged with adequate certainty, it appears that at the present time there is no satisfactory method of ascertaining the hottest point in the winding.

Transformers: The great importance of the transformer in modern high voltage power systems was indicated at the CIGRE meeting by the large number of reports submitted for discussion and the wide variety of their content. Broadly these reports were classified under four general headings: 1, Impulse waves; 2, noise; 3, short circuit; and 4, tap changing under load.

In many ways these reports on transformers were of an unusually specialized and involved nature, reflecting the high state of development of these devices. Curiously enough, the transformer is basically a simple device — two stationary windings linked by a common magnetic circuit — yet its electrical and constructional characteristics, especially in the larger sizes, are enormously complex. The problem of testing transformers, for example, to determine their ability to withstand short circuits, involves many complex questions, many of which are not fully understood. At this meeting there were seven reports on the use of impulse waves and three on tests with chopped waves. The method of impulse testing of a transformer with a wave of reduced steepness chopped on the front was suggested a few years ago by Mr. Stenkvist. This method of testing has been under investigation in France, in Great Britain and in the United States, and while reports from these countries are in agreement on the basic technical background, there is still a question as to whether this test is realistic from the user's viewpoint.

The problem of noise occupied a considerable portion of the time devoted to transformers because of the increasing importance of noise as substations are built in residential areas. The discussion brought out the fact that where the noise could not be reduced in the construction of the transformer itself, the use of shielding external to the transformer itself was most effective. The method of reducing transformer noise by the sound-cancellation method did not appear very effective. Where shielding is used, it was pointed out that the radiators could be installed on the outside of the shielding.

Three reports on the short-circuit characteristics of transformers were presented. The short circuit problem takes on increasing importance as the short circuit power of the systems increases in relation with the development of high capacity circuit breakers and the increase in the rating of transformer units. The calculation as well as the measurement of short circuit stresses in transformers was shown to be a very complex problem and it was pointed out that reduced scale models can be used to good advantage to find the best arrangement of complex windings without complicated calculations. Indeed it was generally accepted that the question of withstanding the short circuit forces on large transformers for large systems is as complicated and painstaking in its way as the impulse problem.

The report by E. C. Rippon of Great Britain on the subject of tap changing under load was very complete and gave an account of his committee's work on this subject. There was some discussion as to whether it was desirable to simulate by test the operation of the tap changer during a short circuit on the system. It was generally agreed, however, that such tests would be extremely difficult and that all practical conditions are met if a tap-changer can switch heavy overloads of short duration, and appropriate type test proposals were given.

Current Interruption: Much of the discussion at the two sessions on the problem of current interruption dealt with the basic theory of the arc formed by the opening of the circuit breaker contacts, particularly with respect to what is generally termed the post-arc conductivity in gas-blast breakers.

It was obvious from the general tone of the discussion that circuit interruption theory and practice has come a long way from the time when Dr. Slepian of Westinghouse first ennunciated his deionization theory in the late 1920's. This was particularly evident from the discussion of the effect of the natural frequencies of the systems upon circuit breaker operation. The breaking capacity of a circuit breaker depends, among other factors, particularly upon the frequency and amplitude factor of the re-striking voltage which appears across the contacts immediately after the interruption of the short circuit current. The natural frequencies of various systems vary from values as low as 400 cps to a high value of 20 kcs, and this wide range seems to make it impossible to standardize breakers with respect to natural frequencies. Mr. Blanford of Great Britain was particularly vigorous in his opinion that it was futile to try to establish standard values for

A. W. Kramer, POWER ENGINEERING editor (left) and R. H. Morris, editorial director, (third from left) talk with European engineers about large electric system problems

natural frequencies and amplitude of re-striking voltages as discussed in two of the reports, 123 and 139.

Figure 2, taken from Report 139, shows the very wide range in the proposed standards for the natural frequency of the re-striking voltage.

One of the problems confronting circuit breaker designers is the difficulty of testing their short-circuit interrupting abilities. The short circuit capacities required today are substantially larger than the power supply equipment even in our highest power testing stations. Furthermore, the possibility of carrying out tests directly on the networks is limited.

For these reasons methods for demonstrating the rupturing capacity by indirect means are gaining in importance. One of these methods is the so-called synthetic test. This was the subject of the material in the report (No. 117) by H. Becker of Sprecher and Schuh, Switzerland.

This synthetic test is designed to bring into judicious action a source of current and a source of voltage. Fig 3 shows the principle involved in the method. Two circuit breakers — the breaker under test, D, and an auxiliary breaker, d — are in the circuit of the current source. The voltage source is connected between the two breakers by means of a sphere gap and a resistance. A high capacity step-up transformer has its secondary arranged in two windings, as shown, one a low voltage winding acting as the current source. This operates at around 40 kv. The other winding supplies current at a much higher voltage, for example, at value of 260 kv.

During the rupturing test the two circuit breakers mentioned are closed first. The short circuit is made by a synchronous closing switch placed between the short circuiting turbine generator and the primary of the step-up transformer. An instant later the circuit breaker under test and the primary breaker open. Whereas the recovery voltage applied to the voltage source is U_2 alone, the circuit breaker under test is subjected to a recovery voltage which is the sum of voltages U_1, and U_2 of the two windings.

Thus the high voltage winding supplies the current for the post-arc phenomena, whereas the low voltage winding supplies the heavy current needed at the instant the contacts open.

There was considerable discussion on this synthetic test and not all delegates were convinced that it was completely effective. Mr. Leyburn of Great Britain felt that his test should be used only for research and not for the practical testing of circuit breakers in production. Mr. Teszner (France) agreed with Mr. Leyburn and was convinced that Mr. Becker's synthetic test could not supply the post-arc current adequately.

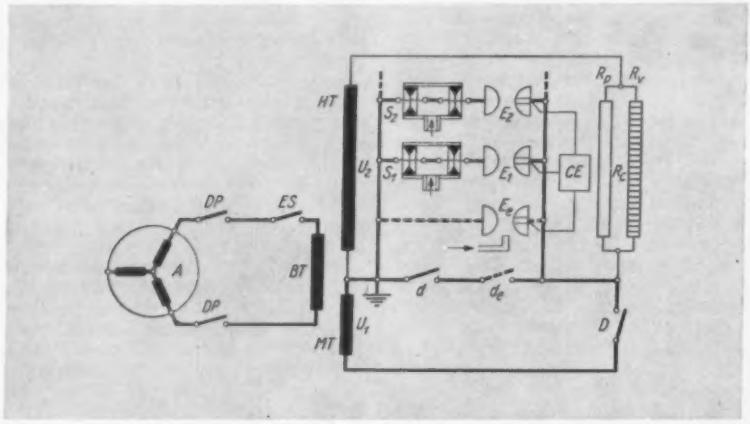


Fig. 3. Synthetic test for showing breaker rupturing capacity by indirect means

A, short circuit turbo-alternator;
DP, protective circuit breaker;
ES, synchronous closer;
BT, primary winding of step-up transformer;
MT, medium voltage transformer winding;
HT, high voltage transformer winding;
U_1, voltage of the heavy current circuit;
U_2, voltage of the high voltage circuit;
D, circuit breaker under test;
d, auxiliary circuit breaker;
d_e, isolating switch of auxiliary circuit breaker;
R_n, link resistance;
R_n, non-linear part of the link resistance;
R_p, constant part of the link resistance;
E_2, striker for closing tests (high speed relay);
$E_{1,d}$, striker for rupturing tests;
CE, control device for the strikers;
$S_{1,2}$ blowers.

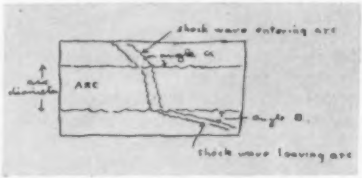


Fig. 4. Principle of method of measuring arc temperature using shock waves

In commenting on these criticisms the author of the report, Mr. Becker, explained that special test circuits had been set up for testing the validity of the synthetic test and he was confident that the method was accurate.

Dr. H. Edels of Great Britain, in discussing circuit breaker arc phenomena, presented several interesting slides of a new method of measuring arc temperatures by means of shock waves. In this method a shock wave, produced by the bursting of a membrane in a tube, is directed against the arc under test and the image of the arc and the wave is studied and photographed by rotating mirrors. The method is roughly illustrated by the diagram shown in Fig. 4, which was drawn from one of Dr. Edels' slides.

Measuring angles a and b and the displacement of the point of entrance with respect to the point of leaving

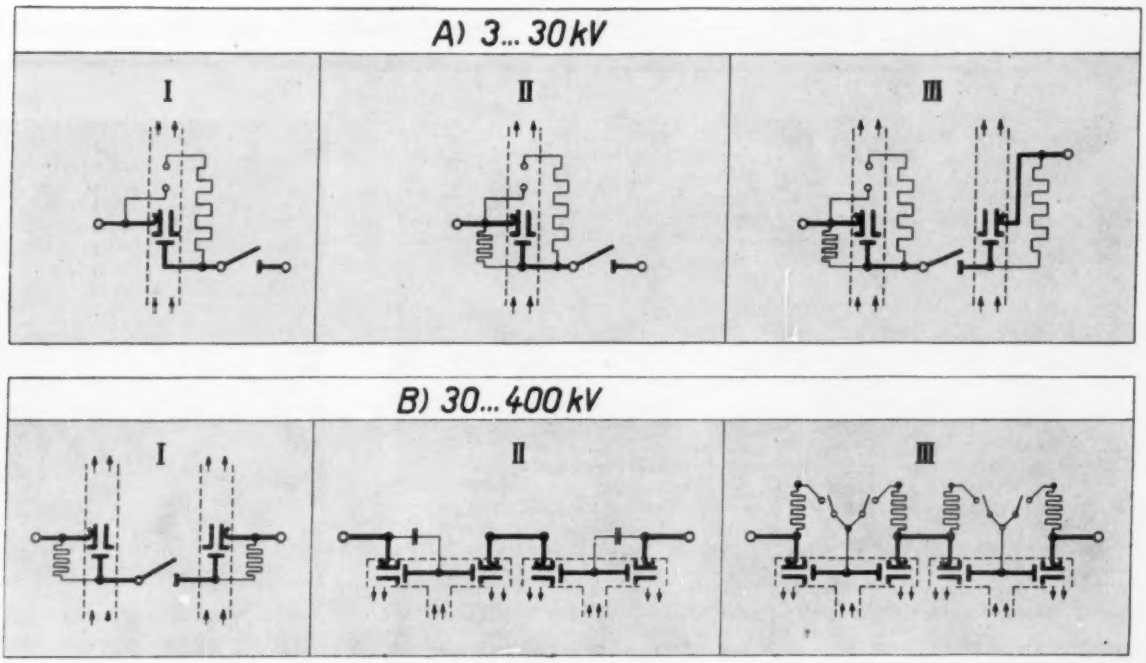


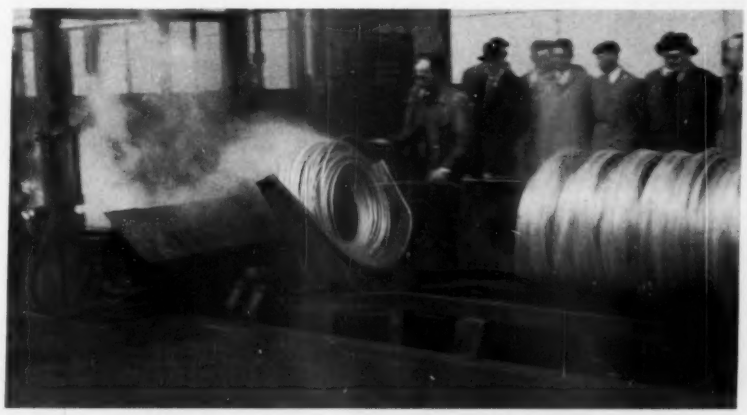
Fig. 5. Some pneumatic devices for arc extinction at various voltages that have proved very successful in foreign practice

gives the data for determining the temperature of the arc during various stages of its existence.

There was considerable discussion concerning the energy transfer between the arc and the electrodes and Dr. Edels also commented on that. With a very short gap, he said, a short time after the current zero, the electrodes are cooler than the arc, and energy, that is, electrons, flows into the electrodes. At a later period, however, the arc is cooler than the electrons and the energy flow reverses. With a longer gap there is less interchange of energy and deionization takes place by recombination of electrons and positive ions in the arc. This theory substantiated Mr. Rieder's (Austria) that post-arc current phenomena was a function of the arc's length. For short gaps, he said, the post-arc current is less because of the fast diffusion of electrons to the electrodes, whereas with long gaps, the post-arc current is greater because of the longer path of travel of electrons to the anode.

These comments cover only a small area of the discussions on interrupters but they will serve to indicate its rather involved and complex nature. They also show the difficulty of formulating standard tests and methods of rating circuit breakers. One of the objects of the committee on circuit interruption is to see whether standardization is possible.

Even the determination of post-arc currents is difficult, though Mr. Byrne (Ireland) said they had been able to measure them by means of magnetic oscillographs. Mr. Byrne questioned the statement in Report 103 on Post Arc Conductivity by Cassie and Mason (England) that the condition in the arc existing at current zero depended upon the history of the arc for the microsecond before current zero. He felt that it was a function of the arc's history over a much greater length of time.



Engineers attending CIGRE meeting were taken, during the conference, on a tour of one of the leading wire and cable manufacturing plants in the country

Mr. Thommen of Brown Boveri was of the opinion that the post-arc current was a function not only of the type of circuit breaker but also of the natural frequency of the system and the recovery voltage. He pointed out that the post-arc current disappears very rapidly with the air-blast type of breaker. Dr. H. Meyer (Switzerland) commented upon the complexity of arc interruption and suggested that in the future papers and reports on post-arc current phenomena be confined to certain types of breakers. Mr. Teszner (France) expressed his opinion that with liquid and magnetic breakers, the number of parameters is so great that much more experimentation is necessary before any sort of uniform standards can be established.

In Mr. Thommen's own report on the most recent progress in the field of air-blast breakers he showed an interesting diagram outlining the various pneumatic devices for arc extinction for different voltages.

These are shown in Fig. 5. These principles, he said, have been proved effective and have enabled circuit breakers to be designed for very great rupturing capacities.

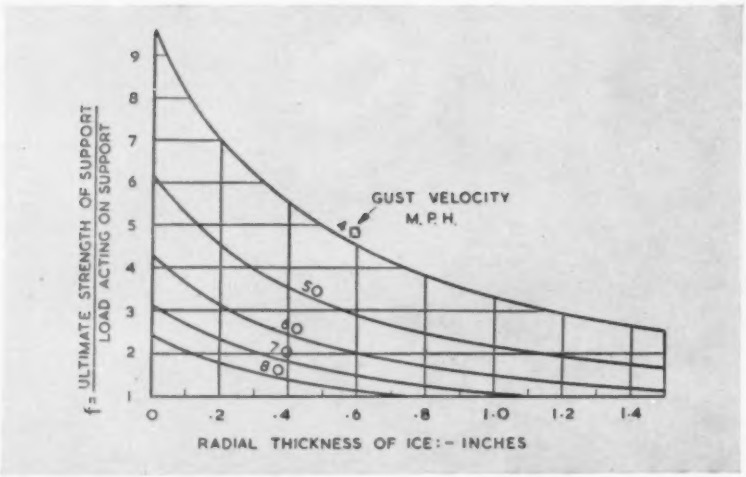
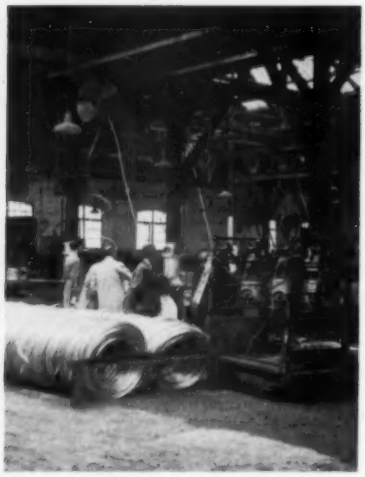


Fig. 6. Safety factors for supports for new 330 kv Australian transmission line



Another view of the French wire mill visited by members during the meetings

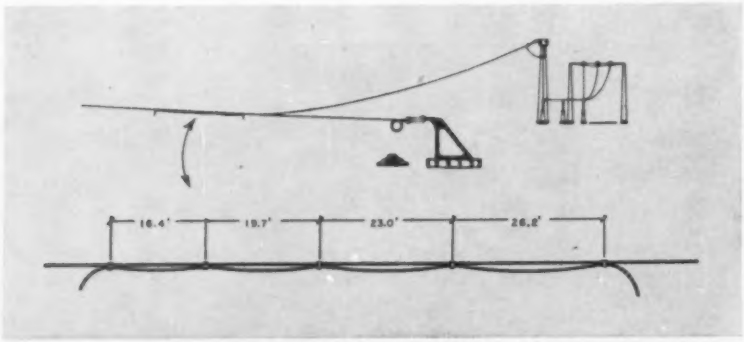


Fig. 7. Anchor ring and suspension for line between Italy and Sicily showing details of vibration damper made of four loops of the cable suspended as shown

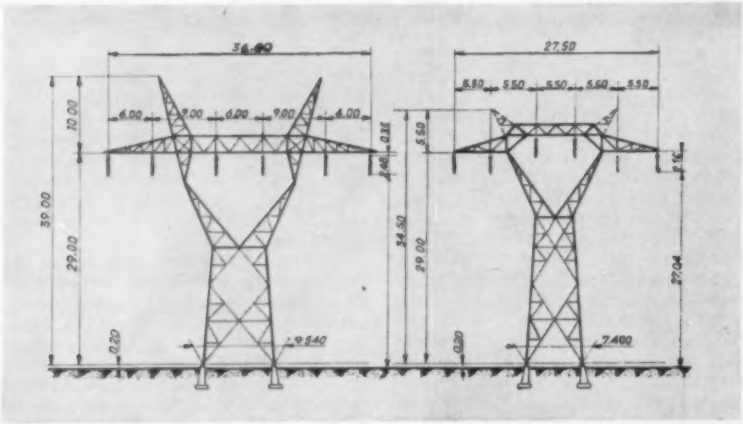


Fig. 8. At right a new French tower design, for two 225 kv or one 380 kv circuits which reduce tower weight roughly a third compared with old tower shown at left

TRANSMISSION LINES criss-cross the earth in patterns as varied as the ideas of the men who build them. Reliability and economy are universal objectives but local conditions and the national economy play a bigger part in the design than does engineering.

For transmission lines, Chile favors copper. The English push aluminum and the Italians say only steel will serve the purpose for spans such as they wish to use. The Germans advocate a concrete lined tubular tower, the French, standard structural shapes, and the Chinese, precast concrete.

Algerians favor hinged cross-arms to minimize the effect of broken cables; the Canadians want more rigid towers; and the Americans push standardization. South Africans oppose the Danes on the necessities for assuming simultaneous high winds and bad ice conditions.

What is considered reasonable reliability in Brazil where cities are served by single circuit lines many miles long is considered ridiculous in British and European areas served by highly developed networks.

Through the conference, however, were overtones from all countries hinting that transmission lines and towers are designed with too high a factor of safety and for unreasonably high structural stability for uncertain and unpredictable circumstances.

"Should we", said one English engineer, "set standards of design for say one tower failure per ten or twenty years per 100 mile of lines?" A Canadian said, "Mechanical and electrical failures have been nil — the question arises whether the

lines have been designed with safety or overload factors which are greater than necessary."

Wind and Ice: From the standpoint of safety and overload factors, wind and ice have received a great deal of experimental consideration previously in France, Sweden, Belgium, Norway, Australia and Germany. (Reports Nos. 206, 213, 218, 220.)

General conclusions regarding wind forces is that the practical effect is much less than designers must allow to comply with regulation in most countries. The conclusion of the Belgian report (No. 206) was:

"It appears from tests carried out . . . that wind pressure on overhead electrical lines is well below the value derived from classical aerodynamic theory." This is confirmed in Germany (No. 220): "From measurements . . . actual wind pressures are lower than those to be taken into account pursuant to regulations."

Additional work in Germany not yet completed indicates that bundled conductors, such as used most extensively on 220- and 380-kv lines in Germany, behave more favorably under wind loads than does each component when used as a single conductor.

In Norway (Report 213) ice formation on an experimental line has been observed to accumulate at the rate of 400 g/m/hr. There are indications that under severe conditions the rate of deposit may run as high as 1000 g/m/hr. In extreme cases, the total ice accumulation may reach 7516 g/m so that line breaks cannot be avoided. Heaviest ice loads come with the high humidity air masses from the south. The dry polar air causes little trouble.

South Africa, following European practice in designing towers and lines for simultaneous bad ice and high wind conditions, made a long study of weather reports and found the two conditions had never occurred simultaneously. This region is rather unique in this respect. Their Australian neighbor on the underside of the world has experienced icing conditions of a mean radial thickness of an inch during blizzards.

Accordingly, the mountain section of a new 330 kv line in New South Wales is designed for ice assuming 2.50 d pounds per foot, where d is the diameter of the conductor in inches. This allows for over 1 in. radial thickness of ice on the 1.053-in. conductor. In exposed sections tension will be adjusted to allow up to 4.25 d of ice to give a safety factor of three at a 40 mph wind gust velocity. Design curves used for supports of this line are shown by Fig. 6.

Hinged outer cross arms are used on this line. Two stay rods prevent the cross arm from swinging but under a predetermined load the tension member breaks away from the tower and allows the cross arm to swing. Discussion in general, however, was critical of hinged or swinging cross arms.

In spite of this criticism, the Algerians (Report 217) strongly defended their use of hinged or rotating cross arms. In common with the majority they felt that for the special conditions under which a new 150-kv line was constructed it was essential that straight through towers should withstand the breaking of one conductor. A hinged cross arm made with a U section brace in compression, not tension, was used as a fuse.

A great deal of work was done in calibrating these fuse members. Tests made in one section of the line confirmed both the accuracy of the design conditions and the performance of the hinged sections. Discussion on line breakage brought out the fact that airplanes cannot be overlooked. In Algeria two recent accidents from this source have been both serious and expensive.

Line breakage and its effect on cross arm and tower design is a matter of almost universal concern. Test lines and towers have been built in many countries including Germany, Japan and Italy. In general, small scale tower tests are not looked upon with favor except for preliminary tests leading to full scale model tests.

Straits of Messina Crossing: The most interesting work along this line was in connection with the 230-kv overhead line crossing the Straits of Messina between Sicily and the Italian mainland. This single span of 3646 meters between towers and 4927 meters from one anchor to the other is a remarkable example of coördinated development, design and construction.

The two similar towers extend 223.70 meters above the base and the four main conductors are suspended about 30 meters below the top section of the tower. Full scale tests of the tower were of course impractical but a model to a scale of 1:25 was tested very thoroughly (Report 231). Full scale tests of the large cross arms were made at the Lecco tower testing station. This test station has over five years experience in tower testing (Report 223). The test results were widely discussed and some of the more spectacular ones shown by slow motion movies.

A special steel conductor cable was developed with aluminum wires for heat conduction. The finished cable has a diameter of 26.80 mm under load, has 120 steel and 19 aluminum wires for a total cross section of 305 and 45 square millimeters respectively. The cable weighs 2.7 kg per meter and has an effective breaking load of 52.3 tons.

It was pulled under tension by means of a pilot wire so as to avoid contact with the salt water. The pilot cable, initially unwound in the water, was looped through a pulley at the far side and returned to the starting point. A traction winch and payout drum were mechanically linked to-

Complete List of CIGRE Papers Available

(International Conference on Large High-Tension Electric Systems) Session 1956 — May 30 - June 9

FOR THOSE interested in papers at this meeting other than those summarized in the present report, we have compiled a mimeographed list of all the papers delivered. It gives the paper number, title of paper, author, and his company or official connection. (Most of the titles are long and descriptive, giving a good idea of what the paper covers, without need for a summary.)

If you want a copy of this list, write the Editor, or write CIGRE LIST on the prepaid return post card in this issue and mail it to us.

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POWER ENGINEERING'S Editor A. W. Kramer (left) with European electrical engineers

gether so that the system was in a state of equilibrium and required power only to overcome the friction.

Figure 7 shows a vibration damper made by festooning sections of the cable itself in 4 loops of 5, 6, 7, and 8 meters.

Construction of the towers themselves was a major project. Construction of the top section of the tower was facilitated by means of a 145-ft floating gin pole. Cross arms were assembled on the ground. The two top cross arms were lifted into place one at a time by a 145-ft gin pole hinged to swing 180 deg. The top sections were then used as anchor points for hoisting main cross arm sections.

Concerned with network systems rather than with long single lines, the French (Report 225) have developed an entire new series of towers at astonishing reductions in the weight of steel required. The new model named "Chat" intended for two 225-kv or one 380-kv circuits is shown at the right of Fig. 8, compared with the old design on the left.

On a typical tower the weight has been reduced from 6600 kg to 4300 kg both designs being intended for the same stress and operating voltage. The new tower is made up solely of angles or flat strips which are available on the French market whereas pipe and special shapes are not.

Some interesting details of a test tower built in France to test the tendency of cable to untwist under tension are shown in Fig. 9.

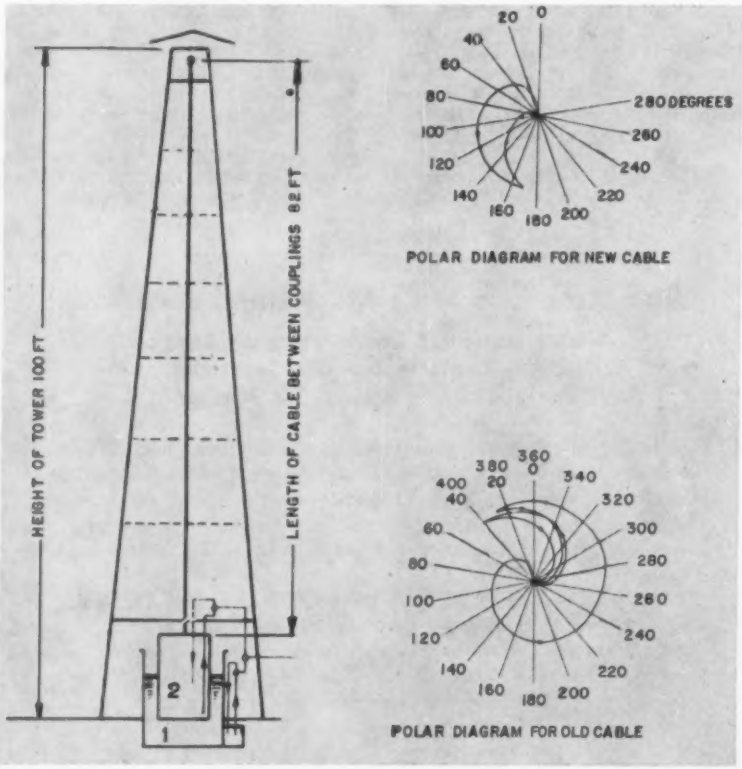

Fig. 9. Special tower built in France to test tendency of cable to untwist under tension, and polar diagrams for two steel-aluminum cables. Upper diagram is for old type, lower for improved cable of same aluminum section but greater stability

Considerable success has been attained in pouring concrete in caving soil combined with a high water table. After testing to failure, examination of such footings showed little or no intermixing of soil and concrete or of muddy water and concrete.

Probably the most critical and comprehensive review of the conference was presented against this background of Canadian experience and background. The fact that mechanical and electrical failures have been nil or extremely rare brings up the point of overdesign, adherence to unreasonably high standards, and high costs.

Better planning and orderly construction can do much to cut costs, and classification or standardization can also save money. Discussion of standardization found few supporters and many critics, generally on the theme that standardization would hamper future developments. The American and European concepts of the subject of standardization differ radically on traditional rather than logical grounds.

Steel as the accepted and most widely used construction material bore the brunt of the discussion although Canadian practice and claims for wood up to 230 kv generated some discussion as did the Chinese practice in the use of reinforced concrete poles precast in sections.

Aldrey, an Al-Ni-Li alloy has had a long and satisfactory service in the Swiss mountains subject to low temperatures and overloads due to snow (Report 211). Introduced about 30 yrs ago, the use of alloys of this type has steadily increased to 134,000 kilometers of conductors by 1954.

In this group the paper (Report No. 209) which induced the most discussion and critical comment was the 301-kv, all aluminum oil filled cable installed at the Kemano-Kitimat hydro project in British Columbia. While agreeing that it was a daring project, and well executed, many questions arose as to details of why it was not done other ways. The best answer to criticism seemed to be: "The cables have now been in service for nearly two years without any untoward incident."

Insulator flashovers in many locations have proven serious. One serious case in England was reported as having been solved with reasonable satisfaction by a grease application.

In Hungary a method of joining aluminum and copper conductors has been developed and has been used successfully for cross sections of from 5 up to 1000 sq mm. This involves a "short time" or high speed electric weld.

As summed up by one speaker in the closing session, the major value of the conference discussion on cables was (1) to emphasize the need for standards and standard tests and (2) to point out the need to get away from considering cable making as an art.

Operation, Protection and Interconnection of Systems

SYSTEM STABILITY: In introducing this subject of System Stability control, S. B Morehouse of Leeds & Northrup Co. in Philadelphia outlined briefly the philosophy of operation in the U. S., pointing out that in the U. S., interconnected power systems derive their generating capability from many separate and independent private utilities representing a large variety of financial interests. He indicated that for each of these financial interests to be served to advantage, the country was divided into a number of separate areas. The fundamental philosophy of operation is that it is the responsibility of each area to absorb within that area its own load changes. This principle, Mr. Morehouse said, pinpointed the difference between the operating philosophy in the U. S. and that in some other countries.

In discussing this problem, however, Mr. Cahen of France pointed out that load frequency control had been used in France as early as 1936, and that both the American and European points of view are similar and the sizes of the systems also are similar. Morehouse reported groups of systems involving capacities of 37,000,000 kw. In Europe, Mr. Cahen said, the groups total some 30,000,000 kw. The law of load frequency control, he said, remains in use at the frontiers of European groups of systems, although control operation may be different in each of them. It is only when you examine the details within each country's network that you find any real difference. Use of different methods of system operation in each of the different countries, Mr. Cahen said, did not prevent tie lines between France, Belgium, Germany and Holland.

System Control: There was some discussion on the use of models in studying system control and Mr. Favez explained that micro-models had been used to some extent in France for this purpose. Mr. Venikov of the Soviet Union, however, was of the opinion that experiments on reduced scale models could not be depended upon unless the problem of similitude was taken into consideration and that even then, tests on models should be supplemented by tests on small actual power systems. Such procedure, he said, was used in the studies on the Kuibishev-Moscow transmission system. He said that there exist in the Soviet Union not only micro-models but also calculating tables of five different models. One model in Russia, said Mr. Venikov, is used only for high frequency variations.

Bundled Conductors: Mr. Cahen discussed the use of bundled conductors in improving stability. There was little difference of opinion concerning the effectiveness of bundled conductors in improving stability but wind stresses, he said, become more important and the lines are more costly. For voltages of 380 kv, the Europeans have adopted bundled conductors and above 420 kv this becomes indispensable. Factors which are still uncertain are the action of ice and behavior of spacers.

The use of series and shunt capacitors for improving system stability is obviously increasing in countries all over the world. Mr. Crary of the General Electric Co. felt that, for long lines, series capacitors are desirable apart from any other considerations and that at the moment they are economically justified. Mr. Lalander, however, was of the opinion that some factors had not been taken into consideration and if these factors were properly considered, series capacitors might appear less advantageous than shunt capacitors. This question was raised also by Mr. Tsai. He pointed out that the shunt capacitor offers the advantage that it can be located on the low-voltage side of the transformer and that this provides a better loading possibility.

Relay Protection: The discussion of Relay Protection was long and involved and in this account of the meeting we can barely indicate the character of the subjects considered under the heading. First there was the question of relay protection in connection with the use of series capacitors. Next was the problem of mounting protective relays and arrangements for testing and maintenance. Third was the grounding of generators. Fourth was the opening of system loops in case of out-of-step operation. Fifth was the location of cable faults.

The Relay Committee's 80-page report on this subject is extremely complete and there was very little time for anything like adequate discussion of the subject at the CIGRE meeting. All groups or individuals interested in the subject of protective relaying should read this report — No. 320 — since it gives a fairly complete outline of the most modern relay practice all over the world.

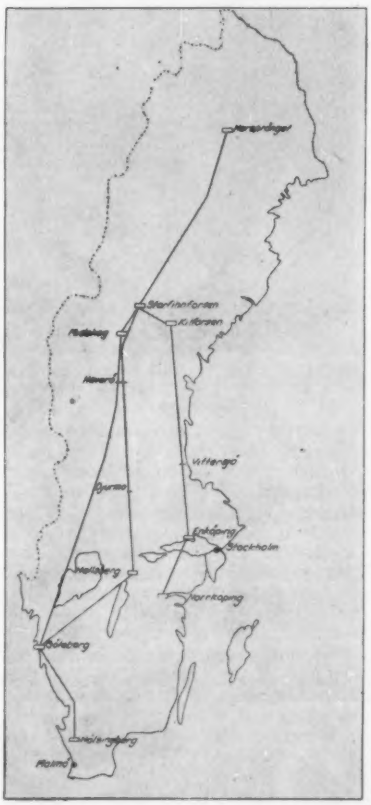

Fig. 10. Swedish 400-kv transmission system in 1956 stage of development

Extra High Voltages

THE REPORTS and discussions under the heading of Extra High Voltages were covered by two sets of sessions, one devoted to high-voltage a-c systems and the other on high voltage d-c systems.

The general report on very high voltage alternation current systems was prepared by Philip Sporn of U. S. A., but because of Mr. Sporn's absence from the meeting was presented by M. H. L. Melvin also of U. S. A.

Mr. Sporn's report drew attention to two important problems which have arisen and which have been the subject of important investigation all over the world. These are, first, disturbances to radio communication due to corona effects, and secondly, insulator flashovers on very high voltage lines due to lightning discharges. In spite of all precautions, flashovers occur on systems much more often than theoretical considerations indicate. He also emphasized the increasing acceptance of bundling transmission line conductors, i.e. arranging lines with 2 or more conductors per phase. He also called

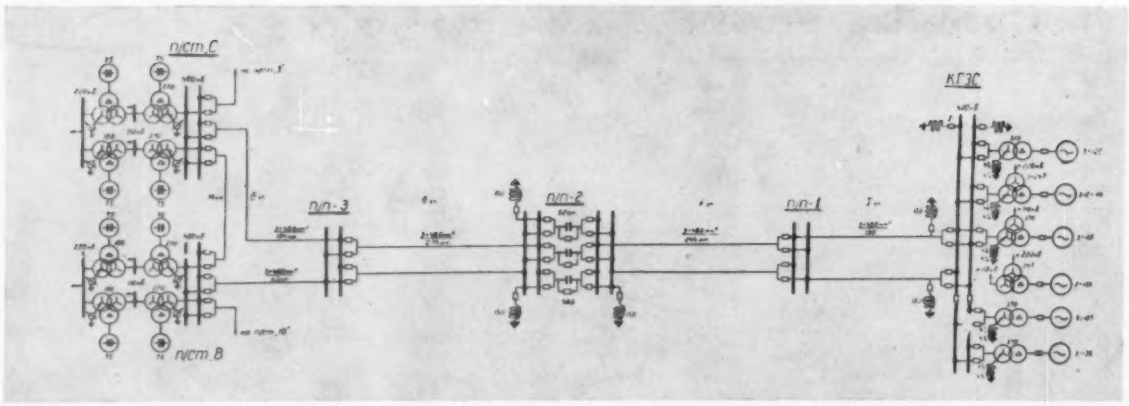

Fig. 11. Circuit diagram of the Kuibishev-Moscow 400-kv transmission line described at the meeting by the USSR delegation

attention to the increasing use of shunt reactances and series condensers in very high voltage systems.

It is very evident from these reports and the general discussion at the CIGRE meeting that extra high-voltage transmission is being used increasingly for the bulk transmission of electrical energy as well as for transmitting electric power over long distances. The need for very long transmission lines is especially urgent in Sweden where it becomes necessary to link the hydroelectric power resources in the north to the important centers of consumption in the southern part of the country. The Swedish 400-kv system in the 1956 stage of development is shown in Fig. 10.

Bundle conductors are being used on all 380-kv lines; two per phase being used in France, England, and Sweden, and three being used in Russia. In Sweden, a third conductor is being added in some instances to the present two-conductor arrangement.

In Germany four-conductor lines are being constructed. Bundle conductors are being used in several countries on transmission lines as low as 110 kv, largely to increase line capacity.

Of great interest was the report presented at this CIGRE meeting by the USSR delegations, describing the 400-kv Kuibishev-Moscow line already mentioned. The line consists of two circuits connected as in Fig 11.

An ACSR conductor is used having an aluminum cross section of 480 sq. mm and a steel cross section of 59.7 sq mm. There are 54 aluminum strands and 19 steel strands in the conductor. Each phase consists of three conductors located at the apexes of an equilateral triangle having a 400 mm base.

The neutrals of the 400-kv windings are solidly grounded. The highest operating voltage of the line is 420 kv (rms). Direct stroke lightning protection of the transmission line is effected by two ground wires running along the entire route of the line and providing shield angles of 15 to 20 degrees.

In the discussion Mr. Lebedfv of the USSR commented briefly on the tests which were carried out before the line was placed in service. The characteristics of the line were measured by an array of 60 magnetic oscillographs and 30 special cathode ray oscillographs connected to various points of the line and operating simultaneously. The characteristics were determined not only for the normal operating frequency of 50 cps but also for higher and lower frequencies ranging from 10 to 1300 cps. When the line was switched off when operating at 310 kv, the transient voltage was twice normal voltage without the reactors. With the reactors, it was 1.1 normal.

Two reports from Japan summarized progress in the development of high voltage transmission in Japan. Report 404 by T. Shinbara described the Sakuma 275-kv transmission system transmitting the output of the Sakuma hydro plant to Tokyo at 50 cycles and to Nagoya at 60 cycles. It is noteworthy that these lines consist of single conductors 34 mm in diameter.

Tests described in the German report, No. 402, gave results of radio interference measurements on the Mannheim-Rheinau line in Germany. These tests confirm the fact that the use of bundles of conductors is by far a more suitable solution than the use of single conductors of large diameter. Tests also show that with respect to the losses and disturbances, four-conductor bundles are more effective than two-conductor bundles.

Summarizing, the numerous reports presented at this CIGRE conference emphasize the great development of alternating voltages higher than 225 kv all over the world. It is obvious that potentials of 380 to 420 kv will be used in at least five European countries in the very near future. This voltage was first used in Sweden in 1952, in the USSR during the past year and it will be used in Germany and France in 1957. Finland will use it in 1958. In Sweden, as indicated previously, the necessity for transmitting power over very great distances has initiated the design of systems operating at 500 kv and possibly even 650 kv.

High-voltage D-C Transmission: For a number of years the idea of using dc instead of ac for high voltage power transmission has received serious consideration. This idea is particularly attractive where power has to be transmitted through submarine or underground cables. Until recently, however, the absence of suitable conversion equipment has limited the application of this idea. Now, however, progress is being made in the application of this idea.

A first commercial HVDC (High Voltage Direct Current) transmission line between two systems has been developed and placed in regular operation in Sweden. This line has a capacity of 20 mw at 100 kv, dc.

In the Soviet Union an experimental d-c transmission system operating at 200 kv with 30 mw over a distance of 112 km has been in trial operation since 1951. Two cables are used for the transmission which normally operates without ground return. The operation is reported to have been gradually improved and to have reached quite satisfactory reliability.

An important factor for a correct comparison of a-c and d-c systems for overland transmission is the practicability of ground return.

In commenting on the experimental Soviet d-c system, Mr. Rokotjaw of the USSR stated that cost analysis indicated that for 750 mw the cost of d-c and a-c installations were of the same order.

Mr. Lalander of Sweden stated that it may be possible to reconstruct a-c lines with a capacity three to four times as high by converting to d-c.

D-c transmission is generally characterized by lower line and higher station costs than for ac. The d-c system calls for a certain minimum distance to become competitive. For an overhead straight-through transmission from a power plant to a receiving a-c network, the cost curves for ac and dc intersect at 530 km (320) units for 1500 mw and at 650 km (390 miles) for 750 mw transmission capacity. For a similar transmission between two a-c networks, the curves intersect at distances 50 to 100 km (30 to 60 miles) greater.

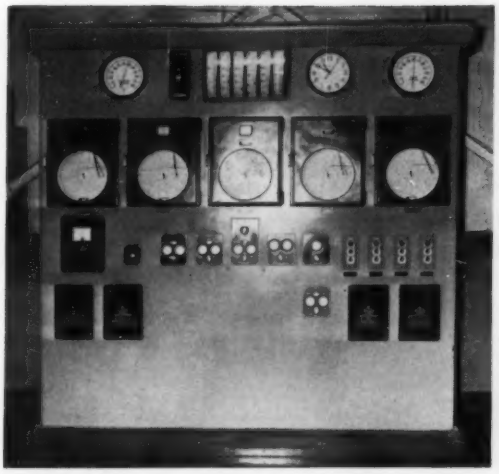

Fig. 1. The control panel for the 80,000-lb/hr steam generator, showing gages, flow meters, and controls

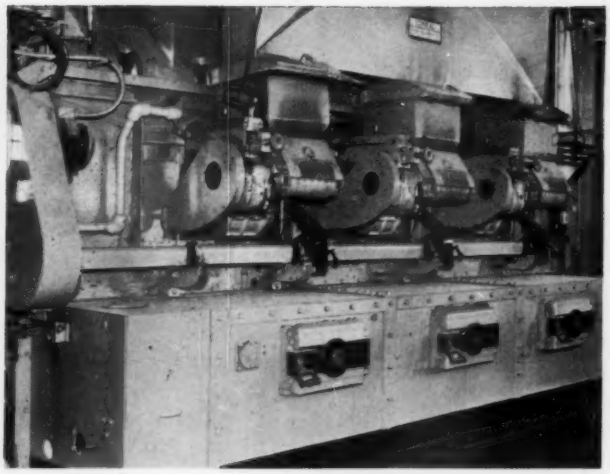

Fig. 2. This front view of boiler illustrates coal distributor to spreader stoker and casing of the continuous ash discharge system

Estimating the New Steam Plant

Estimating costs for a new power plant can be a tricky business —particularly if construction practice and installation procedure are not carefully watched and supervised. Here, in a case history, author shows how planned allocation and diligent follow-through resulted in operation and maintenance costs lower than estimated

By ROBERT R. GILKISON, M.E.

IN 1951 A MID-WEST grain company anticipated that the addition of a new processing plant would increase the process steam demand from 40,000 to 80,000 lb/hr, within two years. To handle the 100 per cent increase, a new steam generating plant was needed. By November, 1953, construction was completed and the plant in operation.

This new steam generating plant consists of one two-drum water-tube boiler, with radiant furnace of 80,000 lb/hr continuous steaming capacity, and a 90,000 lb/hr capacity for two hour peaks; the 200-psi design operates at 160 psi. The unit is equipped with a continuous tube economizer, and dual-firing, by spreader stoker, with continuous ash discharge for coal; ring-type gas burners are provided with forced draft combustion air for natural gas.

New building was constructed for housing the complete equipment of the new plant, with one wall as party-wall to the existing plant built in 1946. A full basement was included to provide adequate space for the water-treating equipment, ash-handling system, forced-draft fans, feed-water pumps and storage of chemical materials.

Existing plant consisted of two integral furnace water-tube boilers of marine type, each having 20,000 lb/hr continuous steaming capacity and 25,000 lb/hr for two hour peaks; these were of 450-psi design, for initial operation at 160-psi, 400-F final steam temperature.

The boilers in the old plant were installed with 450-psi design pressure for future operation at 400 psi to provide steam for turbines that would exhaust at 160 psi for process steam supply. After the plant was placed in operation, the consideration of electric power generation was abandoned.

Production Not Interrupted

Necessity of providing for continuous production of steam for process during construction of the new plant required that the installation of the new unit and its auxiliaries be made entirely independent of the existing plant until completion of the new plant, when a pre-arranged shut-down of process plant was made to permit interconnection between the main steam headers of the new and old plants.

Before construction contracts were executed for the new steam plant, the consulting engineers prepared estimates of the proposed construction costs, including the expected operating cost and anticipated maintenance costs.

The estimated total new investment of the completed plant was $480,000.00. On the basis of installed capacity, the cost as estimated was $6.00 per pound of steam.

Determination of the expected operating costs of the new steam plant required not only an estimate of the annual steam production anticipated, but also the establishment of the operating practice to be placed in effect by the plant management after the new unit was placed in service.

The set-up for the combined steam generating facilities was that the 1946 plant with its capacity of 40,000 lb/hr should be considered as 50 per cent firm stand-by for the new plant, and that the old plant would be maintained for that purpose.

An expected annual operating cost of $183,000, including burden charge for old plant, was fixed, and on that basis the unit cost per 1000 lb of steam was 65.3 cents.

Comparing the above costs with those of the old steam plant operations, the generation of steam with the new plant reflected a savings of $63,000 annually. This comparison then indicated the obsolescense of the old plant equipment and performance. When the new unit would be out of service and the old plant generated the load, a loss of $180 for each day of operation would be entailed.

Considering the fuels to be supplied, an efficiency of 84 per cent for

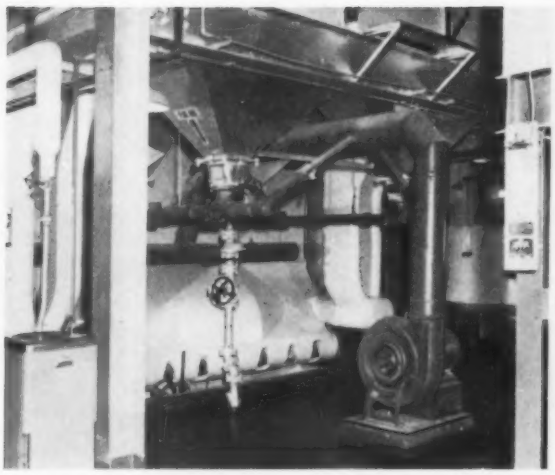

Fig. 3. Rear view of furnace shows high-pressure over-fire air blower and re-injection equipment on 80,000-lb/hr unit

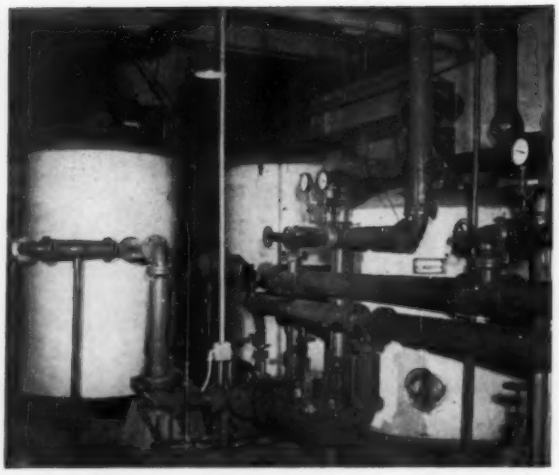

Fig. 4. Zeolite and filter tanks of water treatment system. Good planning of new building lowered costs below estimate

coal firing, and 81 per cent for gas firing the new unit was anticipated; this estimate was based on 11,300-Btu coal and 970 Btu per cu ft for gas.

Automatic controls were incorporated in the new plant design in order that a minimum of operators would be required for each shift; labor-saving coal handling and ash removal equipment were also furnished. It was contemplated that one operator per shift would be ample, with an extra man on the day shift three days per week. The amount of capital invested for automatic operation was justified by the amount of fuel savings to be realized, and by elimination of labor costs. These two items represent the greater percentage of the total operating costs. However, a balance must be made between the savings benefit and the increased burden charge imposed on the operating costs by the additional invested capital.

Actual Cost Less Than Estimate

The actual construction cost of the completed plant was $443,000.00, or $5.54 per pound of steam capacity, as compared with the estimated cost of $480,000.00 and $6.00 per pound of installed steam capacity.

Several factors contributed to the lower final cost, the first being the splendid coöperation rendered by the owners' plant engineer and his staff with the consulting engineer's office during the construction period and start-up operation.

This new plant was built according to a definite construction schedule, with delivery of equipment to be made so that each piece of the equipment upon arrival at job site could be installed, without interference, in its final location in the plant ready for interconnection with other component units of the plant.

Contract drawings were all prepared with arrangement of the equipment and sufficient details so that a minimum of field time would be required for installation and construction. Services rendered by the manufacturers' engineers speeded up the completion of equipment installation and preparation of the new plant start-up, and were especially helpful in making the usual corrections necessary during preliminary operations.

Coal Selected by Burning Tests

Burning tests were made using washed screenings from suppliers located near the plant, to select the most suitable and economical coal fuel supply for the new plant during periods when gas fuel would be curtailed.

Eight-hour tests were conducted during periods of process steam demands at near capacity of the new unit, and with automatic combustion controls 14 per cent CO_2 was obtained for coal and 11 per cent for gas.

Five separate tests resulted in the attainment of an over-all efficiency for coal firing of 83 per cent, and for gas firing, 81 per cent.

Actual steam costs, when firing with coal costing $6.00 per ton, have been officially established at 59 cents per 1000 lb, and for gas, costing 2½ cents per therm, at 57 cents per 1000 lb.

Actual operating costs of the new plant have provided a total savings of $83,000.00 per year, in comparison with operating costs of the old plant. Thus, the actual construction cost, representing an initial capital investment of $443,000.00, is being amortized at a rate requiring only 5⅓ years for complete return of the investment.

Since November, 1953, the new unit has been in almost continuous service without involuntary shutdown. It has made an excellent service record, carrying peak loads of 86,000 to 88,000 lb/hr, without requiring additional maintenance. The plant is maintained with good housekeeping, and the color scheme of the entire plant adds to the general good appearance and certainly provides the operators with a desirable place to work. The company does not experience any transit labor.

The consulting engineers have completed a 1956 rehabilitation program for the old steam plant, which the management has indicated it intends to authorize to incorporate improvements that are expected to reduce the steam costs and, at the same time, provide an increase in capacity that will supply firm standby for the 1953 unit of approximately 100 per cent.

Summarizing the relative estimated steam plant costs, the fact that actual construction cost was under the estimated cost supports the employment of the procedures generally used by consulting engineers to control not only contract purchases but field operations as well to keep the completed plant cost at lowest possible figure.

Supervision Important

However, in keeping the costs low, sacrifice of good workmanship cannot be permitted. Continual supervision and elimination of delays, and ensuring that construction units are completed on time, all help to prevent the final cost from being excessive.

Actual operating costs, when compared with the estimated, indicate the value of proper selection of equipment suitable for the services to be rendered, properly engineered equipment location, and interconnections for labor saving and economical material supply.

When the appropriation for a new plant has been properly allocated, a continuing low operating cost is generally realized.

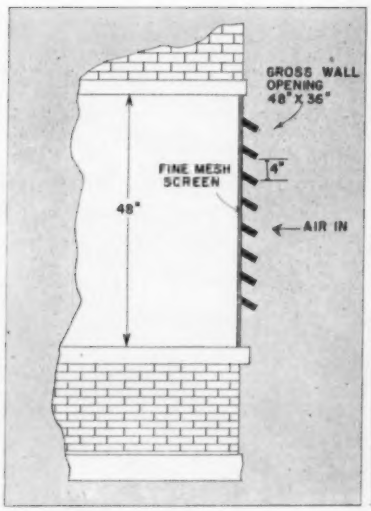

Fig. 1. Air inlet screen and louvers for air conditioning cooling coils can overload system if not properly sized

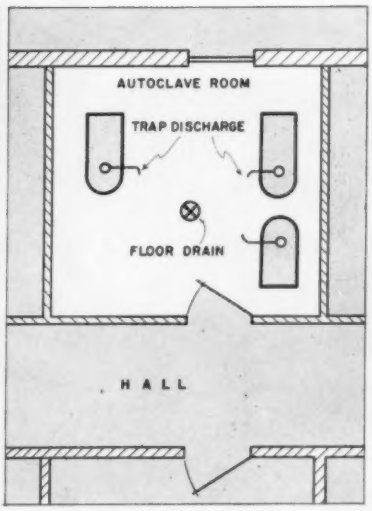

Fig. 2. Corrosion and deterioration of fixtures and equipment can result from improper venting of moisture and steam

Is This Happening in Your Hospital Operations?

Some Simple Cures for High Costs

By C. T. BAKER, C.E.

ENGINEERING investigation of the mechanical, electrical, and refrigerating equipment of public institutions often uncovers amazing customs in connection with the operation of the machinery and equipment. Recently I was retained to make a survey of the entire plant in a county-owned hospital to determine the reasons for high operating costs — including fuel, power and plant repairs. Many practices that came to light were, to say the least, unusual.

Over-heated Operating Room

On the third floor of the building were one minor and two major operating rooms. These rooms and the recovery and operating rooms on the second floor were all air-conditioned from a central plant. There was, of course, no re-circulation of air — only fresh, outside air, filtered and cooled, was circulated through these rooms. The design conditions called for cooling to 53 F and re-heating to 58 F.

Even though this air-conditioning plant had been well designed and properly installed, with ample capacity for handling the cooling load in mid-summer, there were complaints about the excessive temperature in one of the third-floor major operating rooms.

A thermometer placed in the ceiling air outlet showed an entering air temperature of 82 F. With the usual number of high-intensity lights over each operating table, it was to be expected that surrounding air temperature would rise to thoroughly uncomfortable heights.

In this case, a defective modulating valve on the one-inch steam supply to the re-heat coil in the cold-air supply duct was the culprit. Closing a hand valve on the steam supply line until repairs to the automatic valve could be made corrected the trouble.

I was introduced to a new application of the reverse cycle of cooling and heating in this institution. The six-cylinder 3¾ x 3-in. Freon 12 compressor which was thermostatically controlled, operated in winter as well as in summer. Regardless of outdoor temperatures, the incoming air was further cooled by passing through the cooling coils. Leaving the cooling unit, the air passed through a steam re-heat coil — one in each of the three supply ducts — where its temperature was raised to the required point for introduction to the air-conditioned rooms on the second and third floors.

This, of course, meant the consumption of extra fuel, plus the cost of power at the rate of 1½ cents per kw for a 30-hp compressor motor. No one could explain why this method of operation had been followed for a number of years.

Needless to say, the practice has been changed, and the compressor is shut down at all times when outdoor temperatures are low enough so that no further cooling is required. Actually, outside temperatures are low enough during several months of the year. When temperatures are too low for admission to the operating rooms, the re-heat coil in each supply duct acts to ensure comfortable conditions.

Probably the principal reason for the wasteful practices that prevailed can be traced to the attitude of some members of the Board of Directors who, until recently, could not see the advisability of putting an intelligent, responsible person in charge of the mechanical equipment of the institution.

Inlet Area Restricted

Other conditions found in the air-conditioning plant also contributed to its failure to perform satisfactorily. Among these was the air inlet louver which exposed the cooling coils to the outside air supply. Not only was the louver itself too small to pass the required amount of air, but a very fine woven wire screen had been placed on the inner face to guard against entrance of mice, birds, etc., to the system. While this precaution is necessary, it is also essential that ample air space be provided in screens to prevent loss in pressure from high air resistance. An enlarged screen area is being installed with the frame attached to the building wall opposite the air inlet louvers. This will provide a screen surface on both sides and at one end of the aluminum frame holding the screens and will be of sufficient area to prevent obstruction of air flow.

It would be interesting to know how much money has been wasted for power and fuel over the past years by needless operation of the refrigerating compressor.

Naturally, in a plant of this size with a group of buildings heated by steam, many steam traps are required to handle the condensate resulting from the operation of the heating system, kitchen equipment, laundry, etc. The interesting thing is that not since the buildings were erected had a single trap strainer ever been removed for cleaning, nor had one trap been tested or opened for inspection.

Although some of the radiator steam traps have been in service ever since the raditors were installed over fifteen years ago, they have never been inspected.

Over-Heated Autoclave Room

Just why so many hospitals turn loose hot condensate from their autoclaves on the floor of the rooms housing such equipment has never been explained. In the hospital under discussion, such "standard" practice was followed. There were large quantities of hot condensate and steam vapors

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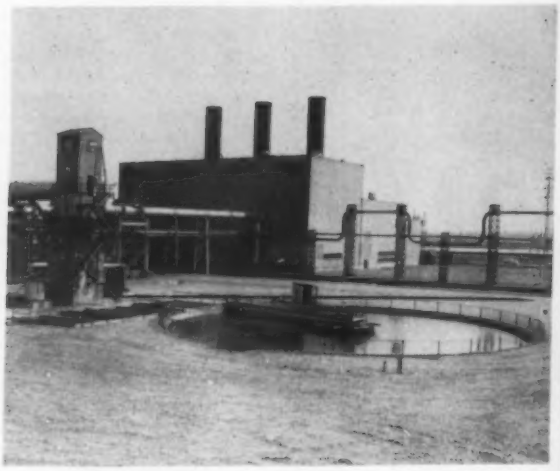

Fig. 1. Clarifier for blast furnace flue dust shows in the foreground; plant power house in background. Fig. 2. (*Right*) Rubber and brick-lined waste pickling liquor storage tanks

How U. S. Steel's Fairless Works Keeps Delaware River Clean

Pointing the way for American industrial plants of the future, the Fairless Works of United States Steel Corporation shows how it is possible to use billions of gallons of water each month and then return it to a stream cleaner at times than it was when pumped in for process

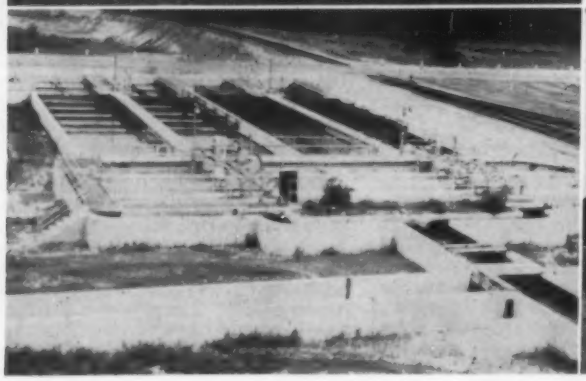

Fig. 3. (*Left*) One of four glass-enclosed sludge drying beds and clarifier, sewage treatment plant. Fig. 4. (*Left, below*) Aeration tanks of terminal treatment plant. Fig. 5. (*Below*) Covered trickling filters, unusual feature of sewage treatment plant

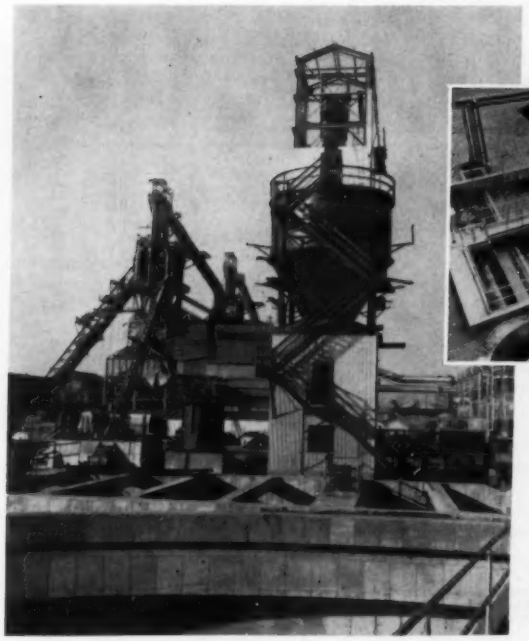

Fig. 6. (*Left*) Flue dust treatment is located at the site. Fig. 7. (*Above*) Oil separator for palm oil from tin rolling mills. These oils are insoluble. Fig. 8 (*Right, above*) The settling basins of terminal treatment plant. Fig. 9 (*Right*) one of the big sludge storage lagoons at modern Fairless Works

Editor's Note: Our nation's water supply, like all other natural resources of this continent, was once thought to be practically unlimited. Only comparatively recently has there arisen a growing awareness of the fallacy in this belief — more and more individuals and organizations are coming to the realization that there is a limit to the amount of water reserve on which we can draw. Industry, once a major offender in the pollution of water supplies, and still a whipping boy for the uninformed, spends millions of dollars each year to prevent stream pollution. Today, industry is in the forefront of those forces that contribute to public welfare by helping to keep our waters clean. This article, based on a paper contributed to the Ninth Industrial Waste Conference at Purdue University, has been selected to demonstrate the extent to which industry will go in helping to prevent the pollution of our natural water resources.

Although it is an outstanding case, made possible only by integrating the system into the design from the very conception of the plant, it is a guidepost for the construction of future industrial facilities of similar nature.

By G. A. HOWELL*

WHEN SOMETHING NEW, be it a new home, a new store, or a new neighbor, enters a community, the residents are naturally curious, somewhat speculative, and rightly concerned. They begin to ask themselves these questions: How will the physical structure of the community be altered; how will the new residents fit into the community; and, most important, will they assume their share of responsibility in maintaining the high standards of the neighborhood?

When it was announced that an integrated steel mill would be built at Morrisville, Pennsylvania, on the Delaware River near Philadelphia, these same questions undoubtedly were uppermost in the minds of the residents of the community. This small farming township, steeped in historical tradition, was bound to be greatly affected by the Fairless Works, an industrial unit encompassing 3800 acres and capable of producing over 2,000,000 tons of steel each year.

U. S. Steel engineers were directed to design a modern, efficient steelmaking unit capable of producing quality product at low cost. One additional requirement was emphasized; this plant must create and maintain good will among the neighboring populace. In brief, the responsibilities of being a good neighbor were recognized and built into the Fairless Works.

A problem of major importance in this program was prevention of stream pollution from industrial wastes. The varied processes of steel manufacture require great quantities of water for cooling and cleaning; most of this water must be returned to the river after it has served its purpose. To provide complete treatment of the waste waters, facilities were installed at the plant site.

The variety of products produced at Fairless Works results in a variety of industrial wastes. Primarily, these wastes include acids, alkaline solutions, oils, both soluble and insoluble, settleable solids and other miscellaneous wastes. The problem of stream pollution is accentuated by the location of the plant. Some 30 miles below the plant, the city of Philadelphia and other consumers depend upon the Delaware river for their water needs. With this in mind, our engineers designed and installed treatment facilities which, we believe, are unique in the steel industry. Where possible, waste waters containing mill scale, acids, flue dust and concentrations of oils and greases are treated at their source to such a degree that the effluent may be discharged either directly to the river or to a separate treatment plant near the river, as required. This separate terminal treatment plant services all process non-acid waste waters. Effluent from the terminal treatment plant is of such a quality that it may be discharged directly into the stream or recirculated through the plant water system. (See complete flow diagram in Fig. 10.)

Design of the treatment facilities at Fairless Works was based on these underlying principles: First, segrega-

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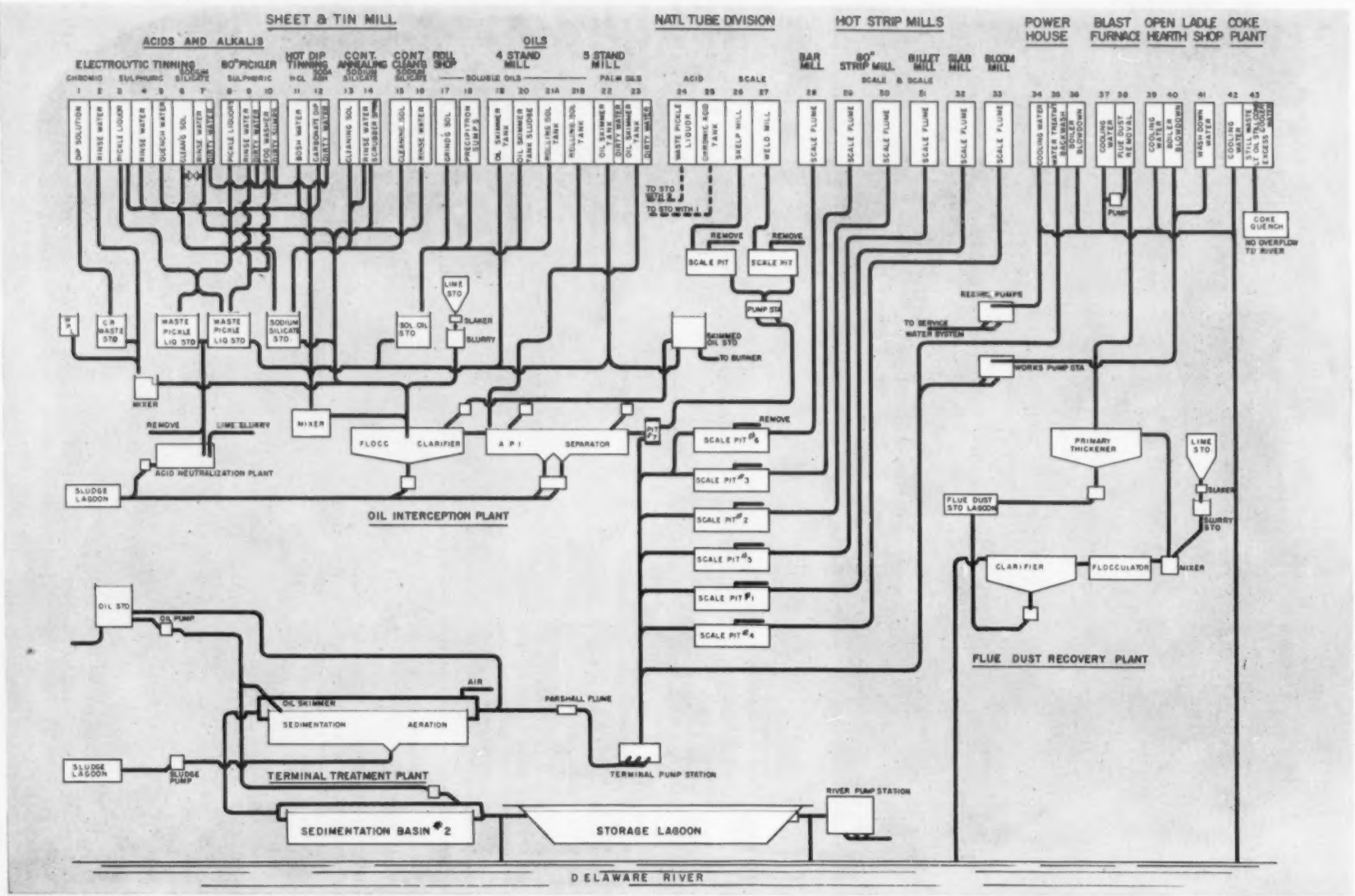


Fig. 10. Flow diagram of the waste treatment system at Fairless Works of U. S. Steel Corp. Note that acid and scale from adjacent National Tube Division plant is also handled

tion of wastes by their essential characteristics; and second, combining wastes to treat them most effectively. Thus, for example, oil and acid wastes are concentrated in one area for treatment; namely, the oil interception plant.

Acid Wastes

Acid effluents are discharged from both batch and continuous processes. This condition requires adequate storage facilities for each group of similar wastes so that pro-rating of the waste flows may be combined for most effective treatment.

Chromic acid, used to provide a protective coating on finished electrolytic tinplate, and sulfuric acid pickling liquor, used to remove oxides and dirt from the surface of the steel in preparation for coating or further processing, are combined with rinse waters containing varying concentrations of acids in one of two 1500-gallon reaction tanks. A one hour detention time is provided to insure complete reaction. The union of these two elements reduces hexavalent chromic acid to tri-valent chromium sulfate. The chromium sulfate flows to a clarifier where a line slurry is added to precipitate the chromium as chromic hydroxide.

Storage for waste acid pickling liquor is provided by two 200,000-gallon rubber and acid-resistant brick-lined tanks (foreground, Fig. 2). Normal operations call for continuous removal by truck of all waste pickling liquor not required for the treatment of chromic wastes. If a breakdown should occur in the trucking system, these tanks will provide adequate temporary storage space for the waste. If for any reason full treatment is required for all waste pickling liquor, sufficient lime handling and slaking capacity have been provided for neutralization in a series of four wooden reaction tanks. Sludge accumulation can be pumped to a storage lagoon for subsequent removal. Normally, the lime slaking plant supplies slurry for treatment of other wastes in a combination flocculator and clarifier, in addition to the chromic acid unit previously described.

Alkaline Wastes

Alkaline wastes are utilized effectively to increase the pH of the acid and soluble oil wastes. Cleaning solutions containing sodium orthosilicates from the electrolytic tinning, continuous annealing and continuous cleaning lines are stored in a 23,000-gallon tank from which the combined wastes are pro-rated and combined with a continuous flow of rinse water from these same sources. Also included is sodium carbonate from the hot dip tinning facilities. This combined flow, along with the chromium sulfate solution and oil sludges, is fed into the combination flocculator and clarifier. Lime slurry is added to the flow in the flocculating chamber to raise the pH to about 9.0. This addition will also cause precipitation as hydroxide of any metals in the solutions. After mechanical flocculation, the liquid flows into the clarifier through an inverted siphon where it is clarified by settling and mechanical removal of solids and scum. The overflow then passes over a peripheral weir to further treatment. In brief, the unit consists of mechanism for automatic mechanical flocculation, gravity sedimentation, and removal of solids and scum, all contained in a 60-ft diameter tank; this unit is shown in background of Fig. 2.

Soluble Oils

Soluble oils emanate from the cold reduction mills and various grinding operations where it is used as a lubricant and protective element. These are all combined and stored in a 42,300-gallon tank. This oil is combined with that from an oil skimmer tank at the mill and a predetermined flow from the skimmed oil tank.

Proper treatment of these wastes requires cracking of the emulsion. This is done by combining the oil flow with a flow of waste pickling liquor, acid-contaminated bosh water from the tin machines, or fresh acid in a flash mixer.

Detention time of 28 minutes is provided for the total flow, while the propeller in the flash mixer will turn over the contents once in ten minutes or nearly three times during the detention period. This unit is an open-top, brick-lined tank 22 ft in diameter and 12 ft deep. It is equipped with an electrically-driven propeller-type flash mixer.

Effluent from the flash mixer, combined with previously mentioned chromic and alkaline wastes, enters the flocculating chamber for 25 minutes mechanical flocculation, and thence into the clarifier for a detention period of 1¾ hours. A rotating skimmer arm removes oil scum which is pumped to the skimmed oil storage tank and eventually into a sludge storage lagoon. Sludge from the clarifier is pumped to a storage lagoon and the effluent passes to the oil separator for further treatment.

Insoluble Oils

A continuous pro-rated volume of insoluble palm oil from tin rolling mill skimmer tanks is combined with the clarifier effluent to pass through an oil separator. In addition to this flow, intermittent discharges, containing about 70 per cent palm oil, are stored in a 42,300-gallon tank. Retention in this tank permits the oil to rise and be decanted to a 23,800-gallon palm oil storage tank, where it can be removed periodically. The aqueous portion from the insoluble oil storage tank flows to the oil separator.

The oil separator (Fig. 7) provides a total detention time of 40 minutes with two stages of clarification. Briefly, the unit consists of two parallel rectangular concrete tanks, each divided into a primary chamber 48-ft long and a secondary chamber 42-ft long, equipped with a mechanical sludge and scum scrapers, and scum remover troughs. All the skimmed oil is pumped to the 23,800-gallon skimmed oil storage tank to await further disposition. Sludge from the bottom of the separator is pumped to a storage lagoon and the overflow from the secondary chamber discharges to a sewer leading to the terminal wastes treating plant near the river.

Roll Mill Scale

Roll mill scale is an oxide coating that forms on the outside of hot steel when in contact with the atmosphere. It is hard and abrasive and must be removed to insure proper surface quality of finished steel.

The mill scale is flushed from the mill with hydraulic water into two-chamber settling pits providing 15 minutes detention. The pits are essentially deep, reinforced concrete structures that permit periodic scale removal by a perforated grab bucket. The secondary chamber of the scale pit is longitudinally partitioned to provide quiescent flow during scale removal. It is interesting to note that nearly two-thirds of the effluent from these pits may be recirculated through the plant cooling system. The remaining water is pumped to the terminal treating plant for further processing.

Miscellaneous Wastes

Wastes such as backwash waters from the water treatment plant at the Power Station, blowdown water from waste heat boilers at the open hearth shop, washdown water, and floor drainage all are directed to the Terminal Treating Plant. All non-contaminated cooling water can be recirculated or discharged directly into the river.

Terminal Treating Plant

To permit centralization of control, the terminal treating plant is located in close proximity to the river pumping station and the sanitary sewage facilities. All industrial waste waters, except those laden with blast furnace flue dust, are handled here. The treatment facilities of this plant are briefly, a pumping station, influent flume, aeration chambers, presedimentation tanks, settling basins, and a storage lagoon (Figs. 4, 8, and 9).

A central controls building is located within the area of the treatment facilities and the river pump house. It houses electrical equipment and controls, indicating, recording and totalizing gages, and instruments for flow, pressure, and level measurements. Analyses of water, sewage, and industrial wastes are accomplished in a small laboratory, also housed in the central controls building. This centralization provides the greatest concentration of equipment and installation with a minimum of operating and maintenance personnel.

At this point, all of the industrial wastes *continued on page 132*

Fig. 1. General view of new Presque Isle Plant of Upper Peninsula Generating Co., capacity 22,000 kw, built at Marquette, Michigan, under coöperative plan worked out between a large mining company and a utility company

Industry and Utility Join to Build Presque Isle

Coöperative plan reduces both Upper Michigan power shortage and over-all expense for supplying power to area. Upper Peninsula Generating Co. builds one 22,000-kw power plant instead of having Cleveland-Cliffs Iron Co. build 11,500-kw plant and Upper Peninsula Power Co. build 7500-kw plant, thus solving many problems for both

By JACK D. PRESTON*

WHEN IT WAS demonstrated that the Upper Peninsula of Michigan faced a power shortage, The Cleveland-Cliffs Iron Co. and the Upper Peninsula Power Co. combined forces to work out an economical solution for part of the area in what proved to be a unique arrangement that may set an example for future coöperation between public utilities and industry. The new Presque Isle Plant of the Upper Peninsula Generating Co., constructed as a coöperative undertaking by those two companies, went into commercial operation in the City of Marquette in September, 1955.

Before this plant was completed the two companies had carried on 21 months of temporary operation under a contract jointly executed to provide a source of additional power for the northern and central part of Upper Michigan, as will be explained. As a result of this experience, the contractual arrangements between the two companies appear to be sound and the final phase of the 30-year contract has been entered.

In 1953 an engineering study of Michigan's Upper Peninsula was made for the Michigan Economic Development Commission that revealed there was a severe power shortage, which was hampering the development of the area and restricting the entry of industry into the territory. This shortage was particularly acute in the West Central District served by The Cliffs Power & Light Co. and in the Northwest District served by the Upper Peninsula Power Co., although several of the other districts in the area were encountering this difficulty.

Why Loads Were Rising

Use of electric energy in the Upper Peninsula Power Co. territory was beginning a period of rapid increase. After many years of marginal operation of the copper mines in their territory, a new venture was started with the opening of the White Pine Mine of the White Pine Mining Co. This large operation had again stimulated interest in copper mining; and the territory was, at the same time, feeling the stimulation of the more extensive use of recreation and vacation facilities, caused by general prosperity throughout the country.

In addition, it was seen that the completion of the bridge across the Straits of Mackinac would further increase electric utility sales. These same increases in development were being experienced in Marquette County, which comprises the West Central District. That district was also looking forward to large increases in power consumption due to the change in method of procuring iron ore. The Cleveland-Cliffs Iron Co., in particular, was planning extensive expansion in the mining, concentrating and agglomeration of low grade jasper ore. The projects that the Cleveland-Cliffs Iron Co. had under immediate consideration required the expansion of electric power production facilities in the Marquette County area immediately.

The shortage of electric power which confronted Upper Michigan at this time was a natural one, which had arisen out of the manner in which that area had been developed. Exploitation of the area's natural resources was conducted by large industrial organizations carrying on the mining of copper and iron and the reduction of forest products into lumber, paper and the chemicals associated with the wood products utilization. Power was a primary requirement of all of these industries. As the application of electric energy to industrial purposes became more general, hydroelectric and fuel burning electric generating stations were built primarily for utilization by industry. However, power for residential and commercial use was made available in the towns and settlements as the demand for such service developed.

During the 1920's this sale of incidental, or surplus, energy to the residential and commercial consum-

*Manager, Electric Power Department, The Cleveland-Cliffs Iron Co., and Vice President, Upper Peninsula Generating Co.

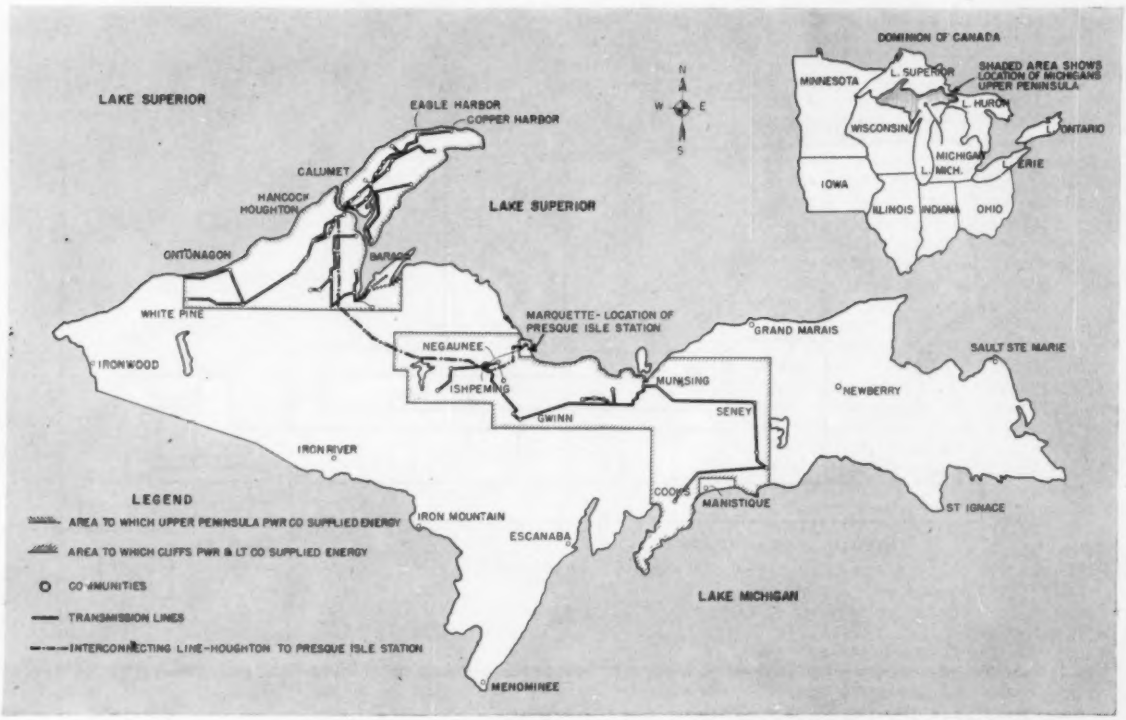


Fig. 2. Map of Upper Peninsula of Michigan, showing locations of areas served by Upper Peninsula Power Co. and Cleveland-Cliffs Iron Co., location of jointly-owned new Presque Isle Plant and location of various transmission systems with interconnections. Insert shows relative location of Michigan's Upper Peninsula

ers in the area increased rapidly, and the rise of governmental regulation of such sales during this period necessitated the setting up of separate organizations to handle the distribution and marketing of this power. Result of this situation, therefore, was a number of isolated utility properties, normally not interconnected, and normally dependent upon the largest industrial development in the area for the production of the electric energy utilized by the community.

Industries Supplied Power

End of World War II found Upper Michigan dependent for its power supply upon a number of small generating stations separated into several small interconnected transmission systems. In many cases, the power for these systems was distributed to the ultimate consumer by an organization which purchased that power wholesale from an industry or from a utility company owned and operated directly by a large industry. These industries were reluctant to spend more to develop the power generating facilities to supply this utility load because the profit was small, and the purchasers were reluctant to have their power prices increased and in many cases, also, the profit from supplying this power did not justify the difficulties experienced with regulatory and utility operating problems. Such industries decided that they would like to withdraw from the business of supplying power for these utility operations, but the distributing organizations were unwilling or unable to make the investments and charge the rates which would pay for the cost of supplying the facilities necessary to generate their own energy requirements. This general condition in the area was specifically illustrated by the conditions which existed in 1953 in the territory served by the Upper Peninsula Power Co. and The Cliffs Power & Light Co.

The Upper Peninsula Power Co., which was supplying energy for the northwest portion of Upper Michigan, was formed in 1947 as a consolidation of three small utility operations: Houghton County Electric Light Co., a utility serving primarily Keweenaw and Houghton Counties in the Copper Country of Michigan; the Iron Range Light & Power Co., a utility serving several municipalities in Iron County, in the Menominee Iron Range; the Copper District Power Co., active in portions of Ontonagon and Houghton Counties. This latter company had been established to supply energy for the Copper Range Mining Co.'s mining operations, and the development had been combined with a utility operating company and extensive utility operations were being conducted.

The Copper Range Mining Co. reduced its mining operations in the early 1930's and this, together with other considerations, made it desirable to dissolve the Copper District Power Co. These three companies were combined to make the Upper Peninsula Power Company which served the area shown in Fig. 2. This company realized, in 1952, that its generating facilities were rapidly becoming inadequate. Plans were under way for the construction of a new power plant in that area to produce 7500 kw.

Mining Operations Change

Similarly, in Marquette County, The Cliffs Power & Light Co. was the source of supply of the major portion of the electric energy utilized outside of the city of Marquette. It was a wholly-owned subsidiary of The Cleveland-Cliffs Iron Co. With the electrification of its mining operations in 1910, this company had, as time progressed, installed 6 hydroelectric stations in the area and had constructed transmission lines connecting these generating stations with its various mining operations. In addition, it was selling energy to other mining and industrial operations as well as to other companies and municipalities operating as public utilities in the area, and in 1926, The Cliffs Power & Light Co., a public utility *continued on page 116*

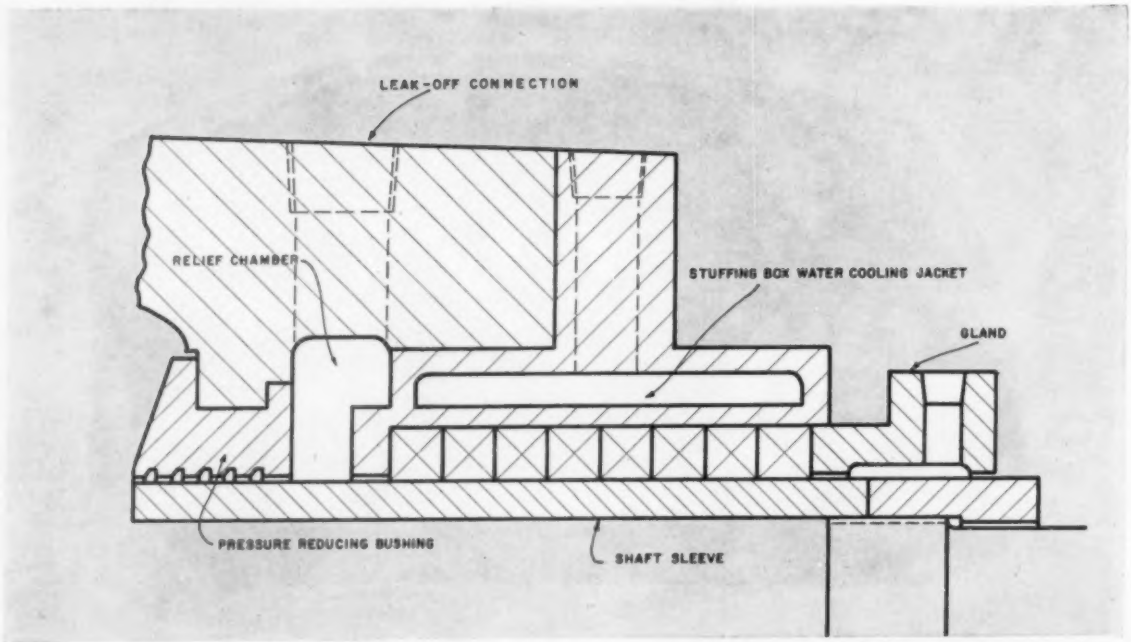


Fig. 1. Example of a pressure break-down. Object is to reduce the pressure at which stuffing box packing has to operate

How Stuffing Box Temperatures Are Reduced

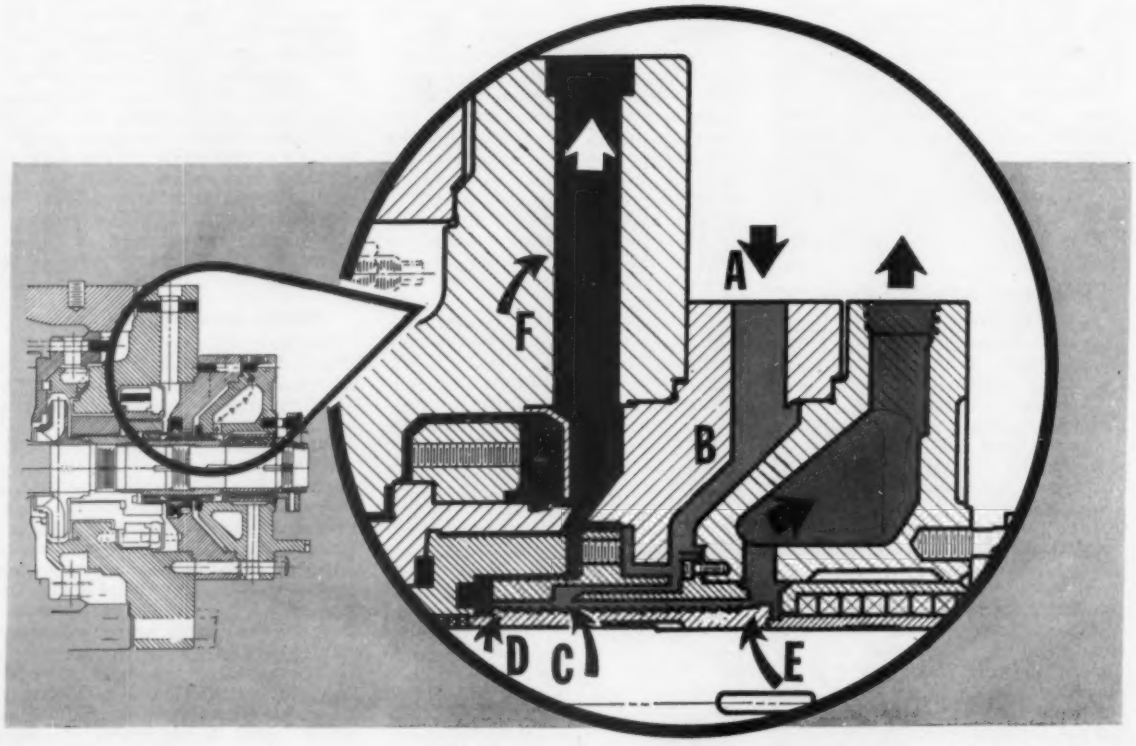


Fig. 2. Section through a double pressure breakdown in which cool water protects the stuffing box packing from hot water

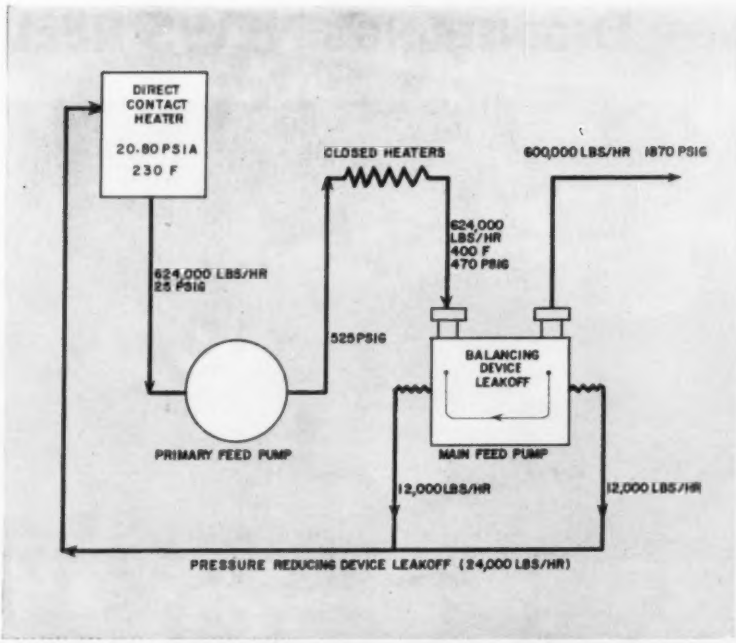


Fig. 3. Feedwater pumping arrangement with pressure reducing devices in main feed

in Modern BF Pumps

This, the second article in a series of four by the same author, discusses some of the ways in which stuffing box packing in modern pumps is protected from high temperatures and pressures inside the pumps

By IGOR J. KARASSIK*

WHEN BOILER feed pump temperatures and suction pressures started on their upward hike in the early 1930's, considerable trouble developed at first in many installations with the stuffing box packing. Some packings burnt out, scoring and wrecking the shaft sleeves. Other packings which did not fail completely, leaked rather badly and required frequent attention and renewal.

It seemed futile to search for packing materials which would have the necessary resistance to heat and, at the same time, retain the required low friction, adequate strength, flexibility, and body. Instead it became the practice, derived strictly from expediency, to reduce the pressure at the stuffing boxes whenever it exceeded 250 or 300 psi, by means of pressure reducing devices.

Single Pressure Reducing Breakdowns: Even today, experience shows that adverse conditions accumulate until a certain combination of pressure, temperature, rubbing speed and other factors is reached when the stuffing box can no longer be packed successfully. When such conditions prevail and it is still desired to use a packed box, it becomes necessary to incorporate ahead of the stuffing box proper a set of pressure reducing bushings or labyrinths. Their function is to relieve the stuffing box pressure by bleeding a certain quantity of feedwater to a pressure sufficiently low to permit satisfactory packing operation.

A stuffing box pressure reducing device consists of a stationary bushing or a meshing labyrinth located between the pump interior and the stuffing box proper and ending in a relief chamber. The latter is piped up to some point in the feed cycle where a suitably low pressure is maintained and the leakage past the pressure reducing device is returned to this point.

A great number of different designs of pressure reducing devices have been used in the past. Fig. 1 illustrates one such device suitable for limited pressures and reasonably low rubbing speeds. In this particular case, a short serrated stationary bushing is inserted at the bottom of the stuffing box and is followed by a relief and collecting chamber. The leakage between the serrated bushing and the shaft sleeve is bled off through a connection to a low pressure point in the feed cycle.

When relatively high pressures on stuffing boxes are encountered, the construction of the pressure-reducing labyrinths becomes more complex. These pressure reducing breakdowns are made of alloy stainless steel to assure long life and low maintenance cost. By reason of the construction incorporated in their design, of reasonably close running clearances and of the length of the leakage path, the leakage from these breakdowns is kept to a minimum. Since the leak-off from the balancing device itself is returned to the pump suction, the leakage from the breakdowns does not affect the hydraulic balance of the pump.

The maximum permissible leakage does not, therefore, depend upon hydraulic balancing considerations, but rather upon the effect on the operating economy of the system and on the maximum pressure desirable on the stuffing boxes. In that particular connection, the adverse effect of increased leakage would be due to a corresponding increase in the friction losses in the leak-off piping which would create a higher back-pressure at the stuffing boxes.

The piping from the leakoff chamber following such pressure reducing devices should therefore be amply sized so that, as wear takes place and leakage increases, there will not be an appreciable increase of friction in the leak-off piping. Thus, if suitably sized piping is installed to handle this leakage, no adverse effect will occur at the stuffing boxes even if the leak-off increases very appreciably because of wear.

We should give some consideration at this point to the effect of the pressure reducing devices on the general economy of the installation. The feedwater bled through these devices to a region of lower pressure must be handled by the pump which precedes the main feed pump in addition to the normal capacity of the system. A certain additional expenditure of power is obviously involved therein.

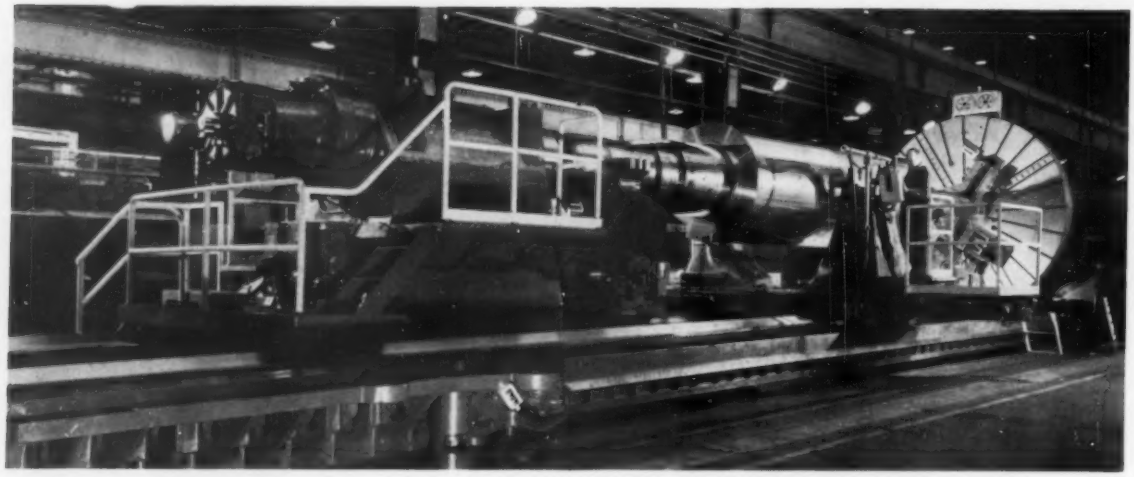
The amount of feedwater bled back will, of course, depend to a certain extent upon the actual suction pressure and the pressure to which the bleed-off is returned. At all events, the power required to re-pump this quantity of feedwater reaches appreciable magnitudes in most cases.

Let us assume, for instance, a boiler feed pump system designed to handle 600,000 lb per hour of feedwater. (See Fig. 3) Our pumping set starts with a primary pump taking its suction from a direct contact heater at 230 F and with a suction pressure of 25 psig. It discharges at 525 psig through a series of closed heaters which bring the pumping temperature to 400 F. Because of the friction losses through the heaters, the suction pressure at the main feed pump is reduced to 470 psig.

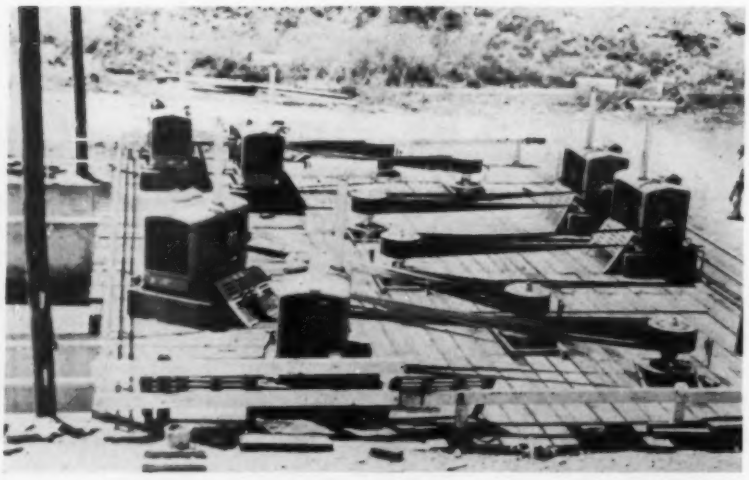
The main feed pump is provided with pressure reducing breakdowns which are *continued on page 132*

*Assistant to Vice-President and Consulting Engineer, Harrison Division, Worthington Corporation

POWER ENGINEERING'S NEWS REEL

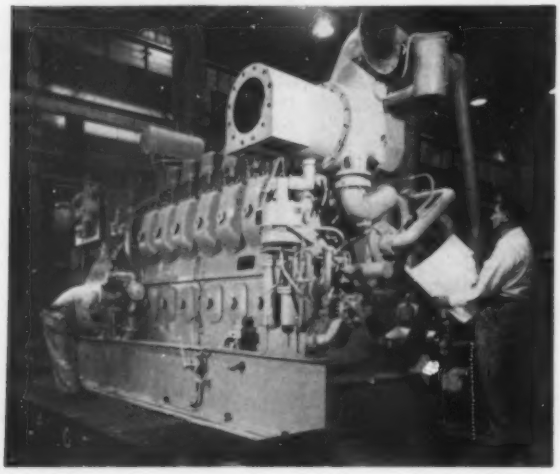


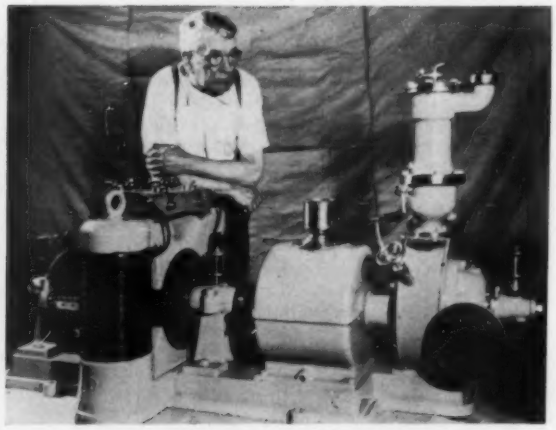
Machining Big Rotor in the Allis-Chalmers shops for a 146,000-kw, 18,000-v, 85 per cent power factor 1800-rpm Type AT4H steam turbine generator



54 Rubber Bands form the link which keeps 120,000 gallons of water per minute flowing into drought-threatened land near Tucumcari, N. M. The "rubber bands" are 35-ft V-belts made by Fort Worth Steel & Machinery Co., and transmit power from 6 diesel engines to a set of six irrigation pumps

First A-C Diesel electric power package from Alco Products is this skid-mounted unit powered with the new Alco 251-B 6-cylinder diesel, and with a 485-kw generator. It's for the new incinerator at Oyster Bay, L. I.



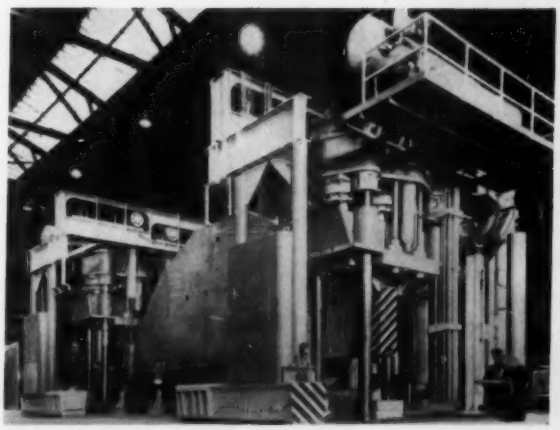


Oldtimer Retired but still going strong. This 10-kw turbine generator was made by De Laval in 1893. It delivered 10 hp at 24,000 rpm. Now it goes to the Smithsonian Institution

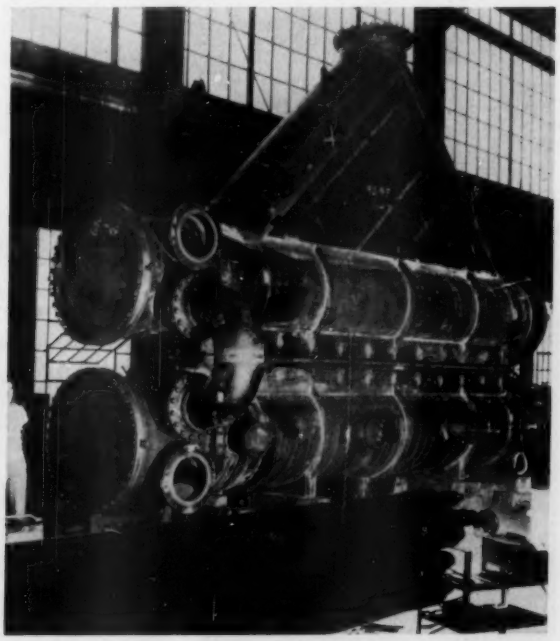
1,450 PSI Boiler, one of the highest pressure industrial steam units, will be installed in this new addition to the plant of the Consolidated Water Power & Paper Company at Biron, Wis.

Atomic First: one of the first two atomic piles has started working at Calder Hall, Cumberland, England, the world's first full-scale atomic power station. Here preparations are being made for insertion of uranium rods at top of the pile

Special Torch automatically welds a tube with an extremely thin wall, a small bead being laid around each tube end. Designed by Griscom-Russell it uses i-g t-a process



Bending Boiler Plate: steel plate up to 7½-in. thick, 36-ft. long and weighing about 50 tons can be bent into half drum shells on this new twin press at Babcock & Wilcox



Installed 80 Feet Up in the air, this 40-ton condenser is used by Gulf Oil to condense overhead vapors from refinery vacuum tower. Shown in plant of maker, Griscom-Russell Co.

Something New Under the Sun—the Cryotron

The device described in this article is the first practical application of the phenomenon of superconductivity discovered by Kammerlingh Onnes at the University of Leiden in 1911. The first announcement of this device and the research which made it possible was at the AIEE meeting at Swampscott last year, in a conference paper by Dudley A. Buck of MIT. More recently Mr. Buck discussed the development before the American Power Conference in Chicago last March. This article is based upon both of Mr. Buck's papers

By **A. W. KRAMER**
Editor, POWER ENGINEERING

SOME 45 years ago, in 1911, at the University of Leiden in Holland, Prof. H. Kammerlingh Onnes discovered superconductivity, three years after he succeeded in liquifying helium. While extending electrical resistance measurements to this new low temperature region he found that the resistance of mercury dropped suddenly to zero at 4.12 K (Kelvin), that is at 4.12 degrees above absolute zero. Soon many other materials were shown to display this same unusual behavior.

Of course it had been known that the resistance of metals decreases with temperature, and this is true of the superconducting materials. Just above their superconductive transition, however, the resistivity is between $\frac{1}{10}$ and 1/1000 of their room temperature resistivity, depending upon the purity and the mechanical strain in a particular sample. Then, as the materials are cooled further, the resistance suddenly drops to zero. Below the superconductive transition the resistance is *exactly* zero. That it is truly zero is vividly demonstrated by an experiment now in progress by Professor S. C. Collins at MIT wherein a lead ring has been carrying an induced current of several hundred amperes since March 16, 1954, without any observable diminution in the magnitude of the current.

The transition temperature varies with different materials. Niobium becomes a superconductor at 8 K, lead at 7.2 K, vanadium at 5.1 K, tantalum at 4.4 K, tin at 3.7 K, aluminum at 1.2 K, and titanium at 0.5 K. In addition to 21 elements, many alloys and compounds are superconductors with transition temperatures ranging between 0 and 17 K.

Resistivity of many of the superconductors is relatively high at room temperature, especially those which have high transition temperatures such as niobium, lead, tantalum, etc. It is interesting that relatively poor conductors become superconductors at low temperatures whereas good conductors such as gold, silver, and copper do not.

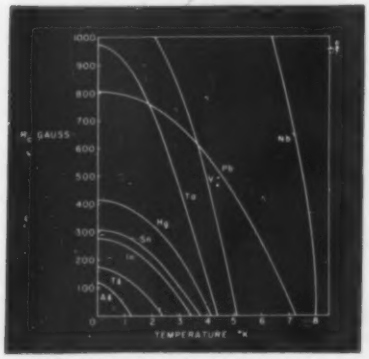


Fig. 1. Threshold magnetic field vs temperature for several common superconductors, as explained in the text

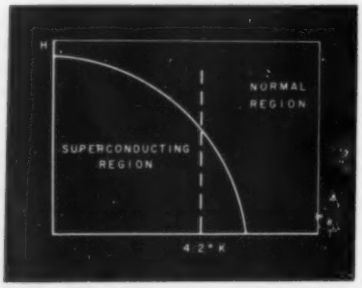


Fig. 2. Threshold magnetic field as a function of temperature for a superconductor, showing field change effect

The Cryotron

Although the phenomenon of superconductivity has been known since 1911, no practical application was ever made of the effect until the one described here. There was, of course, a good reason for this, the fact that superconductivity can be achieved only by immersing the materials in liquid helium. This was not only expensive and difficult to obtain but it evaporated rapidly.

Several years ago, however, the study of nonlinearities in nature suitable for use in the design of small compact computers led investigators at Massachusetts Institute of Technology to the development of a device which they now call the cryotron. This device is based on the destruction of superconductivity by a magnetic field.

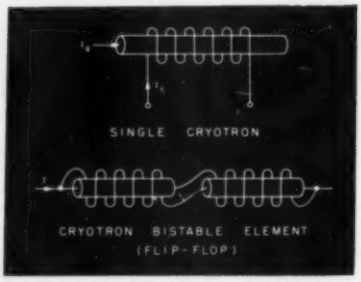


Fig. 3. A single cryotron and a wiring diagram showing how two cryotrons are connected to form a bistable element

Shortly after Kammerlingh Onnes discovered superconductivity he also discovered that the superconductive state could be destroyed by a magnetic field. When a magnetic field is applied, the onset of superconductivity occurs at a lower temperature. If the intensity of the magnetic field is increased, the transition temperature is still lower. A plot of the transition temperature as a function of the applied magnetic field is more or less parabolic in shape, levelling off as absolute zero is approached. Such a plot for several common elements is shown in Fig. 1.

If the temperature is held below the transition temperature for one of these materials, the resistance of that material is zero. Its resistance will remain zero as a magnetic field is applied until that magnetic field reaches a critical value. Above this value the normal resistance returns. If the strength of the field is lowered, the resistance disappears. Raising and lowering the magnetic field thus controls the resistance of the material in the magnetic field by causing it to shift from its superconducting state to its normal state and back without changing the temperature. In Fig. 2, this operation corresponds to moving up and down on a vertical (constant temperature) line which has its lower end in the superconducting region and its upper end in the normal region. If the operating line is moved to a lower temperature the magnetic field

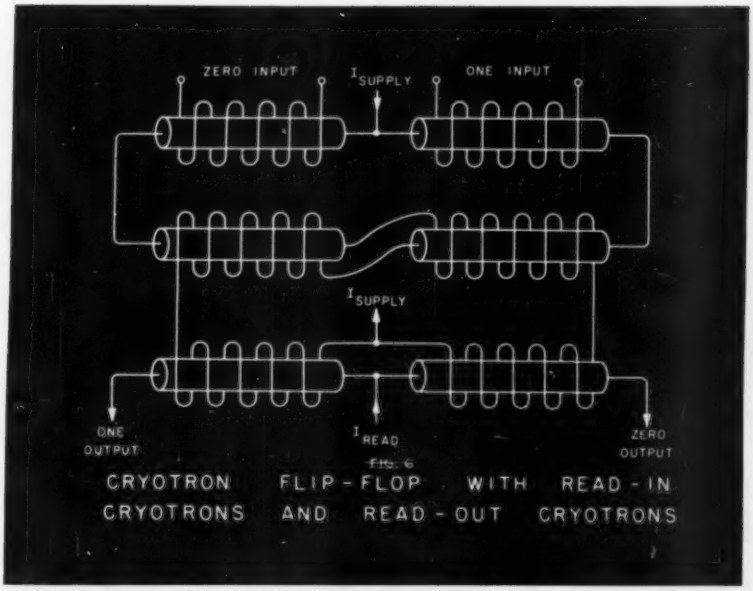


Fig. 4. Cryotron flip-flop with read-in cryotrons and read-out cryotrons; see text

required to reach the normal region is greater. For each of the materials which becomes superconducting, there is a temperature about 0.2 K below the zero-field transition which allows operation with rather small magnetic fields — between 50 and 100 oersteds. For lead, this temperature is about 7.0 K, for tantalum about 4.2 K, for tin about 3.5 K, for aluminum about 1.0 K. Tantalum has been used in many of the early experiments at MIT because 4.2 K is the boiling point of helium at a pressure of 1 atmosphere, and therefore the temperature of most storage tanks for liquid helium.

This principle, then — the control of the superconducting state by a magnetic field — governs the operation of the cryotron. In its simplest form, the cryotron consists of a straight piece of wire about one inch long with a single-layer control winding wound over it. The magnetic control field is generated by current in the single-layer winding (Fig. 3, top). The central wire is analogous to the plate circuit of a vacuum tube and the control winding is analogous to the control grid. In this case, however, the plate resistance is zero in the cutoff region and rises rapidly as the grid-current cutoff is reached.

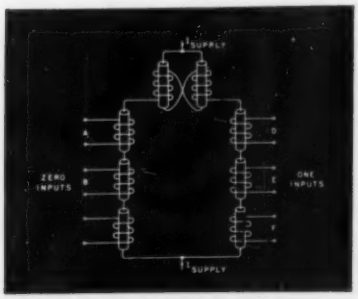


Fig. 5. Cryotron flip-flop with OR gates in both sides; any number can be in series

In operation, current in the control winding creates a magnetic field which causes the central wire to change from its superconducting state to its normal state. The device has current gain, that is, a small current can control a larger current, and it has power gain so that cryotrons can be interconnected in logical networks as active elements. The device is also small, light, easily fabricated, and dissipates very little power.

The control winding is made of a superconducting wire which has a relatively high transition temperature. Niobium (formerly called columbium) is used because it has a very high transition temperature and can be drawn into fine wire which is strong.

At the temperature used, the control winding remains a superconductor at all times, and would remain so even in magnetic fields much stronger than those being used to control the central wire. Therefore there is no resistance in the control winding. A magnetic field, once established, needs no further energy for its support; the control current is maintained against zero back voltage. Similarly, all interconnecting wire is also superconducting.

Cryotron Circuits

This device, then, behaves as a relay. A very small current in the control winding can interrupt the current in the straight wire. Thus, a bistable element, one of the most common in digital computers, can be made using two cryotrons. The two fate circuits are each in series with the control winding on the other and the two paths are in parallel as shown at the bottom of Fig. 3. If the current is established in one of the paths, that current makes the alternate path resistive. Current in one path, once established, will therefore continue to flow indefinitely in that path.

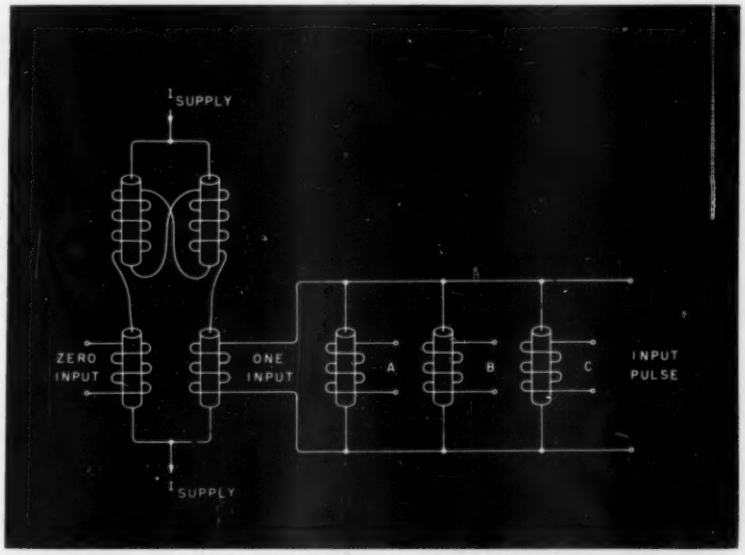


Fig. 6. Cryotron flip-flop with AND gates in one side; gate circuits in parallel

Two additional cryotrons can be added to the circuit, one in series with each branch, in order to place the flip-flop in the desired state. A pulse on one of the two input cryotrons momentarily places a resistance in that side. Both sides are then resistive and the current divides between them. If the power supply current is not larger than twice the criti-

Fig. 7. Three-cryotron flip-flop multivibrator as actually constructed in practice

cal current of the cryotrons, both sides of the flip-flop will become superconducting. One side of the flip-flop has a resistance inserted by the input cryotron, however, and the current thus chooses the other side. Once the current builds up in the other side, it makes the side on which the input cryotron is being pulsed resistive, and therefore the pulse in the control winding of the input cryotron can be removed; the current will continue in the new path.

Two more cryotrons can be added to the circuit for sensing the state of the flip-flop. Placed with their control windings each in series with one of the two sides of the flip-flop, one of the read-out cryotrons is resistive and the other is superconductive. The gate circuits are joined and a read-out current pulse is applied at the junction. The read-out pulse will choose one path or the other, depending on the state of the flip-flop. The flip-flop with read-in and read-out cryotrons is shown in Fig. 4.

Any number of input cryotrons can be added in series with those already described (Fig. 5) to set the flip-flop to one state or the other. Connected this way they are OR gates; any one of them acting alone can set the flip-flop. Similarly, additional cryotrons can be added with their gate circuits in parallel with the control winding of the input cryotron already described, and behaving as AND gates (Fig. 6). The flip-flop set current is bypassed through one or more of these parallel gates unless all of them are resistive. This latter connection involves superconductors in parallel, in which case the current divides inversely as the inductance of the parallel paths.

Other Applications

These few examples will serve to show how the cryotron elements are used in practical circuits. Of course, many other applications are possible. For example three flip-flops made of one-inch pieces of cryotron stock have been studied in a multivibrator circuit. Other studies have involved a multiterminal switch. Also, the principles embodied in the flip-flop and switch can be used to design the stages of a binary adder. Stepping registers, commonly used for receiving digital information in serial form, have also been designed using these cryotron elements. Finally, many interesting circuits can be made of cryotrons with two or more control windings wound over each other in such a way that the net magnetic field affecting the central wire is due to the sum of the magnetic fields of the individual windings.

The most unusual requirement of a cryotron system is that it operate at a temperature near the absolute zero. Ten years ago this requirement would have precluded serious thought of such a system but today such an operating temperature is relatively easy to achieve. This is mainly due to the work of Samuel C. Collins whose helium liquifiers revolutionized the field of low temperature physics. Arthur D. Little, Inc., of Cambridge, Mass., has built 70 Collins helium liquifiers of a 4-litre-per-hr capacity. The liquifier at MIT liquifies 27 litres per hr. Storage of liquid helium has also improved. Commercially available double Dewars which use liquid nitrogen in the outer Dewar lose less than one per cent of their liquid helium per day.

Helium Evaporation

Now, heat dissipated by a cryotron system causes evaporation of the helium. If the average power dissipated per cryotron is 10^{-4} watt, an estimate based on present experimental units, a 5000-cryotron computer would dissipate *one-half watt*. The latent heat of vaporization of liquid helium at 4.2 K is 5 calories per gram, its density is 0.1257, and therefore one-half watt corresponds to an evaporation rate of 0.93 litre per hr. A continuous system which recycles helium would be most economical for a stationary installation; a 10 or 20-litre charge at the time of launching (say on an aircraft installation) would suffice for a portable system.

If the necessity for immersion of the cryotron system in liquid helium should be thought of as somewhat of a nuisance, or if the expense of the liquid helium be considered objectionable, it may be of interest to compare such a system with that of a conventional large digital computer using thousands of electron tubes. The Whirlwind computer at MIT requires the use of a 40-ton refrigerating plant on the roof of the building to supply the cooling air for the tubes. The investment in this air-conditioning system and the cost of operation far outweigh the relatively minor cost of the liquid helium needed for a cryotron installation.

Physical construction of the cryotron elements is simple and compact. The experimental cryotron circuits are mounted at the ends of three-foot cupro-nickel tubes for immersion in a liquid helium storage vessel. Power supply and signal wires come up through the center of the tube. Many materials are used in the construction of circuits to operate in liquid helium. Ordinary wire insulation (enamel, silk, glass, Formex, etc.) shows no sign of failure after repeated immersion. One experiment using wooden coil forms glued together with Duco cement was successful. Scotch electrical tape, while it freezes, seems to hold well. Metals in general are much stronger at extreme low temperatures.

Small size of the elements is of great importance in computer design for aircraft. Extrapolating the volume occupied by the present experimental circuits to larger numbers of components indicates that a large-scale 5000-element digital computer can be made to occupy one cubic foot of space exclusive of refrigeration and terminal equipment. The power required by such a machine extrapolates to about ½ watt, once again excluding refrigeration and terminal equipment. The reliability of cryotron circuitry is not known but it is anticipated that operation in an inert helium atmosphere at a temperature near absolute zero where chemical activity and diffusion processes are essentially stopped promises a high degree of reliability. The circuit noise level is similarly not known, but due to low temperature, every little thermal fluctuation noise is anticipated. The device is at present somewhat faster than electromechanical relays, but far slower than vacuum tubes and transistors. A program is under way to increase the speed.

New Tool

Research leading to the development of the cryotron was supported jointly by the Department of the Army, the Department of the Navy, and the Department of the Air Forces. In the development of this interesting device engineers have a new tool which may have great potential applications in various branches of the electrical art. The cryotron is an element having zero electrical resistance; that, in itself, is a concept very difficult to understand because it is rarely that engineers or scientists have the opportunity of dealing with an absolute quantity. Yet, in the cryotron we actually have a device with zero electrical resistance. Thus, no matter what the resistance of the conductor may be just before the transition temperature, no matter how minute this resistance may be, the ratio between that resistance and the zero resistance after the transition is still infinite.

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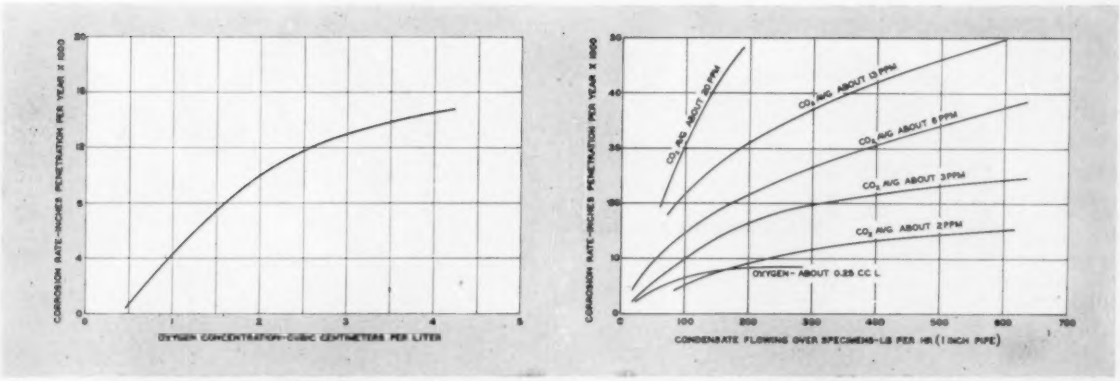

CORROSION RATE-INCHES PENETRATION PER YEAR X 1000
OXYGEN CONCENTRATION-CUBIC CENTIMETERS PER LITER
CO2 AVG. ABOUT 13 PPM
CO2 AVG. ABOUT 8 PPM
CO2 AVG. ABOUT 3 PPM
CO2 AVG. ABOUT 2 PPM
OXYGEN - ABOUT 0.25 CC/L
CONDENSATE FLOWING OVER SPECIMENS-LB PER HR (1 INCH PIPE)

Fig. 1. These graphs show how corrosion is affected by the content of condensate. (*Left*) Corrosion rate as a function of oxygen concentration; pH 6.0 or higher. (*Right*) Relation between corrosion and gas content, varying condensate flow

Corrosion in Condensate System Can Be Controlled

Condensate systems are frequently a focal point for many corrosion problems. When oxygen and carbon dioxide are the offenders—as usually they are—one of the newly-developed chemicals may be a cure for your troubles. Here is an explanation of how they work

By R. G. DALBKE*

CONDENSATE SYSTEM corrosion is encountered in many steam generating plants. This difficulty may be very acute and require frequent replacement of equipment, resulting in large maintenance expenditure and in some cases cause shut-down of important units. There are plants, for instance, which have to replace piping more than once per year. However, due to the use of newly-developed chemicals, the number of such plants is rapidly decreasing.

Causes of Corrosion

Oxygen and carbon dioxide dissolved in water are usually the primary causes of corrosion in condensate systems. Oxygen can be carried into the condensate system with the steam, or it can enter at various other points in the system. Oxygen-type corrosion is usually characterized by pitting of metal walls (see Fig. 2). When present in boiler feedwater, oxygen can be handled properly by use of a well vented deaerating heater, followed by use of oxygen scavenging chemicals in the boiler water to remove last traces of oxygen; this will prevent excessive corrosion of boiler metal and carry-over of the oxygen into the steam.

As stated, oxygen can enter condensate systems at various points. This can occur in vacuum or gravity return systems as well as in intermittently-operated pressure systems. Studeis have shown that where corrosion is due essentially to the presence of oxygen, rate of corrosion remains quite constant regardless of the amount of condensate flowing through the line.[1] †

Carbon dioxide is the most common cause of return-line corrosion. This type of corrosion is identified by a general thinning or grooving of the metal walls (see Fig. 3).

Normally, the principal source of carbon dioxide in steam is the presence of bicarbonates and/or, on occasion, carbonates in the makeup water to the boilers. Under boiler water temperatures, most of the bicarbonates chemically decompose and form caustic soda and carbon dioxide. The resultant carbon dioxide is then liberated with the steam. Bicarbonates in the makeup water may be present in combination with calcium, magnesium, or sodium. If calcium and magnesium bicarbonates are treated internally by use of phosphates or other chemicals, these bicarbonates are converted to their corresponding sodium salts, which then decompose and form carbon dioxide.

In the case of softening equipment, such as sodium zeolite units, all of the bicarbonates are changed to sodium bicarbonates. Sodium zeolite softeners, therefore, are often undesirable since they do not reduce the bicarbonate content of the boiler makeup. On the other hand, lime, lime and soda, split-stream, dealkalizing, and demineralizing equipment reduce or almost entirely eliminate carbon dioxide potential in the steam.

At the boiler temperatures usually encountered, it has been proven that about 80 per cent of the carbonates in the boiler water will dissociate. This is equivalent to 6 ppm of carbon dioxide in the steam for every 17 ppm, or one grain per gallon of total alkalinity in the feedwater. The alkalinity of the feedwater is measured as the methyl orange reading and expressed as calcium carbonate.

Not all of the carbon dioxide goes into solution in the condensate. In the first part of the system the amount of carbon dioxide is only a small fraction of the total vapor. As the steam condenses, the percentage of carbon dioxide in the remaining vapor increases and more will thus go into solution, according to Henry's law. Thus, toward the end of the system, more CO_2 will be in solution and the pH will be lower.

Gaseous carbon dioxide is present in some makeup waters, but normally has little effect on condensate system corrosion since essentially all of it can be removed in a properly designed and operated deaerating heater.

As previously mentioned, carbon dioxide is usually the primary cause of return line corrosion. Extensive studies have shown that the amount of corrosion is proportional to the concentration of CO_2 in the condensate, and the amount of condensate flowing; this is why corrosion in main return lines is often higher than at other points. In most cases, if the CO_2 in the steam is held to less than 5 ppm, corrosion will not be serious. This would be equivalent to

† Numbers refer to list of References at end of article.

*Technical Service Dept., Dearborn Chemical Co.

Fig. 2. Characteristic pitting of nipple from condensate line shows typical corrosion by dissolved oxygen in water

Fig. 3. Corrosion effects of carbonic acid in condensate. Grooving in threaded area of nipple caused leakage in line

a condensate pH of 5.9 if one-half of the CO_2 is dissolved in the condensate. When the pH exceeds 5.9, the rate of corrosion is governed principally by the amount of oxygen present in the condensate. When the pH is below 5.9, the amount of corrosion depends on the quantity of carbon dioxide in solution and the rate at which that condensate flows through the piping.

Treatments Prevent Corrosion

Neutralizing-Type Chemicals — There are two basic chemical methods used to control corrosion in return systems. One method is to use a material to neutralize dissolved gases in the system; another is to use a material which forms a protective film on metallic surfaces.

There are a number of neutralizing-type chemicals used; the most common are ammonia and neutralizing amines. Other chemicals used, but not with any appreciable success, include polyphosphates and caustic soda. Ammonia can be introduced into the system as a water solution or as an ammonium salt. This salt decomposes in boiler water to liberate ammonia gas, which then goes over with the steam and dissolves in the condensate. Ammonia has generally been used in utility plants to prevent corrosion and iron pickup in turbines. It is not the best chemical for this purpose for reasons to be explained later.

The most common neutralizing amines used to control corrosion in condensate systems are morpholine and cyclohexylamine. These materials, when dissolved in condensate, neutralize carbonic acid and raise pH. They are most often fed to the boiler where they are volatilized and then dissolved in the steam condensate. The neutralizing amines are good treatments for relatively small plants having short condensate systems, but are not too satisfactory for large heating plants, as these chemicals, particularly morpholine, tend to dissolve in the first condensate formed while carbon dioxide dissolves faster nearer the end of the system. Since they dissolve in the first condensate formed, such chemicals may be discharged through traps before they have a chance to distribute through the system.

While cyclohexylamine is not as soluble in the first condensate formed in the heating system as morpholine, it has the disadvantage of having a relatively high vapor pressure, and considerable amounts can be lost from a deaerating heater. Generally speaking, if a neutralizing amine is desired, morpholine should be used in the higher pressure plants, and cyclohexylamine in the lowest pressure group.[3]

Neutralizing chemicals, particularly morpholine, are used frequently in power plants to control corrosion in last stages of turbines. Morpholine is better for this purpose than either cyclohexylamine or ammonia as it has the lowest volatility or distribution ratio. This ratio is the amount of chemical in the steam to the amount of chemical in the condensate at a given temperature.[3] Thus, in the last stages of turbines, more morpholine will be dissolved in condensate than would the other products. Another disadvantage, as far as neutralizing amines is concerned, is that since they function by neutralizing dissolved carbon dioxide, the dosage depends on the amount of carbon dioxide in the condensate. For many plants where the amount of carbon dioxide in the steam is high, this is a costly proposition. A further disadvantage is that neutralizing amines generally do very little to arrest corrosion caused by oxygen.

Filming-Type Amines — Another type of inhibitor which was recently developed for controlling return-line corrosion is the filming amine.[4,5] This chemical offers protection by formation of a non-wettable film on metallic surfaces. The required dosage is based on the amount of steam generated by the boiler. This dosage is independent of the carbon dioxide content and is a big advantage in plants having a high concentration of carbon dioxide in the steam. Another major feature of filming amines is that these chemicals prevent corrosion from oxygen, which of course the neutralizing-type amines do not. One of the characteristics of the filming amines is that their use results in the formation of a wax-like coating on the condensate piping. This coating, theoretically, is one molecule thick and does not build up itself.[6]

Amines Penetrate Deposits

In the case of initiating treatment with filming amines in older plants, it is of interest to note that these chemicals will penetrate rust deposits and put a protective film on the metal underneath. Both field and laboratory data show that the life of the film is short when condensate is flowing over it and to obtain the most satisfactory protection against corrosion, continuous feed should be used.

Filming amines may be fed directly to boilers, to steam lines, or to feedwater lines. In the case of application to feedwater lines, the chemical should be applied after a deaerating heater, as considerable amounts can be lost if it is fed ahead of this unit. Also, filming amines may be fed to feedwater lines only if this feedwater is low in alkalinity and hardness, otherwise deposits will form in the system. The application of these amines directly to boilers or to feedwater, where permitted, assures the addition of filming amines to steam by steam distillation from the boiler water. Feeding amines directly to steam lines is of advantage only when it is desired to protect a portion of the system against corrosion.

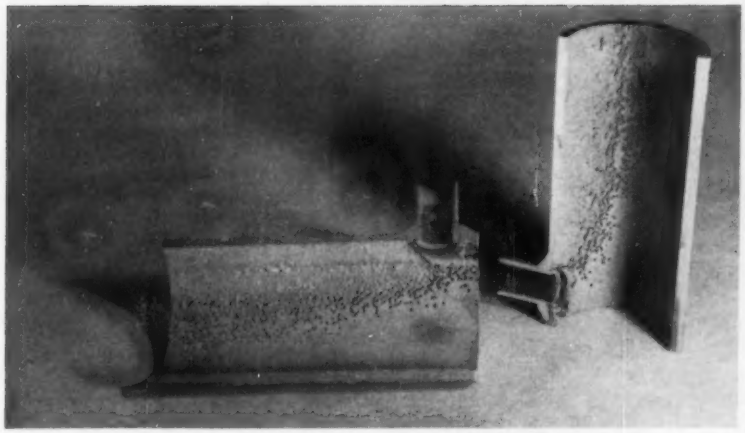


Fig. 4. Cavitation corrosion in pipe due to water hammer from steam collapse. Chemicals are no answer to this problem; cure: relocate cold water inlet in line

Experience has shown that significant reduction in corrosion will be obtained within the first month's application of filming amines. Two ppm is the average dosage applied but the exact amount required depends on the severity of existing conditions and other factors. There is no field test for filming amines and, therefore, initial dosages must be based on steam production and controlled by accurate chemical pumps. The exact dosages thereafter are based on laboratory analyses for amines in condensate samples and also by corrosion rate measurements using ASTM-NHDA Corrosion Testers.[7] These testers, Fig. 5, consist of three coils which are insulated from each other by plastic inserts. The corrosion testers are usually installed in the condensate system for a period of thirty days. At the end of this time they are removed, the coils are disassembled, cleaned, and weighed. These weights are then compared to the initial weights of the units before insertion into the system. Based on the weight losses of the coils, the corrosion rate can be calculated and expressed in mils, or inches per year. Thus, it is possible to obtain accurate information on the treatment performance in the system.

Corrosion Products Loosened

It is of interest to note that when the use of filming amines is started in systems which have been already corroded, the inhibitor will loosen up the old products of corrosion. If these products are removed too rapidly the rust will frequently clog traps and screens. This trouble can be minimized by using a low dosage for awhile. This dosage is on the order of 0.5 to 1 ppm and is gradually increased to the desired concentration after most of the corrosion products have been removed from the system.

In addition to controlling corrosion in steam condensate systems, filming amines have the property of increasing heat transfer in many operations where heat exchanger equipment is used. Use of filming amines is increasing rapidly because of their effectiveness; neutralizing amines will continue to be used in central station power plants, and probably in the smaller heating systems.

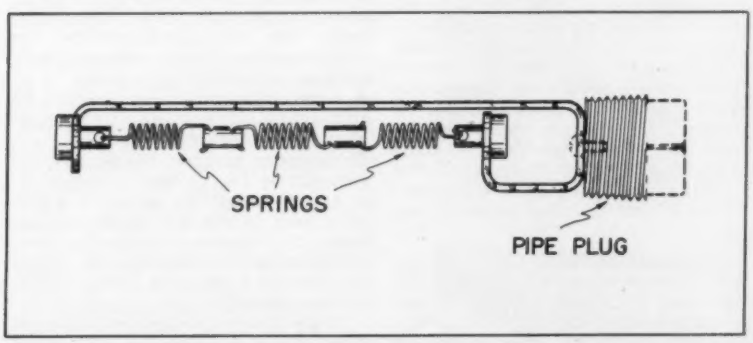


Fig. 5. Standard corrosion tester developed by Corrosion Committee of National District Heating Association. Frame is stainless steel; three coils are made of steel comparable to that used in piping system. (Aluminum coils are also available.) Tests show that significant results can be obtained in exposures of 30 days, and can be used to test corrosion characteristics of condensate, cooling water, domestic water, boiler feed water, or other types of water usually used in industry

Case Histories

1. *Heat Exchange Failure:* A vegetable oil extraction plant built in 1950 included rising-film evaporators and numerous heat exchangers in which tubes failed rapidly by corrosion at lower ends. After two years of service, the plant had to be shut down for complete retubing of heat exchangers at a cost of $25,000.00. After retubing, Filmeen (flaked octadecylamine acetate) treatment of steam was started at 2 ppm. In 2½ years of subsequent operation, no tube replacements have been required, measured corrosion rates have dropped to a minimum, and internal inspection shows negligible corrosion. In addition, process evaporation rate has been increased from 90 gpm to 160 gpm through improved heat transfer, traceable to elimination of corrosion deposits and promotion of dropwise condensation on the steam side of evaporator tubes.

2. *Cavitation Resulting from Steam Collapse:* In the same plant, certain evaporators and exchangers were located several hundred yards from steam generators, and it was necessary to reduce condensate temperature before repumping to the power plant. This was accomplished by injecting cold water into a large return line, 50 ft ahead of a condensate receiver. Steam collapse in this line caused violent hammering, and frequent corrosion failure due to cavitation effects. Although the remainder of the condensate system was protected, filming amine treatment did not arrest cavitation failures in this short section. When the point of cold water injection was moved to the condensate receiver, steam collapse and cavitation were eliminated and return lines thereafter were fully protected by Filmeen.

3. *Economizer Deposits:* In a paper mill, Filmeen was applied to feedwater in the storage section of a deaerating heater supplying a 600-psig boiler and lower pressure units. Raised gradually to 1.5 ppm, the treatment arrested corrosion in paper machine air heaters and return lines. However, after six months, inspection showed that sticky deposits, consisting largely of octadecylamine and precipitated phosphates, had developed on economizer tubes at top and bottom headers. No deposits were found in feedwater lines or boilers. After cleaning economizer tubes, the chemical feed system was re-piped to discharge Filmeen solution to steam headers. In addition to other benefits to production, direct labor savings *continued on page 134*

Fig. 1. Beads of weld metal and other particles embedded in babbitt bearing surface. If bearing had been operated much longer it would have failed completely

You Must Keep Dirt Out For Good Lubrication

In July we showed why dirt in a lubricating oil system can do so much damage to machines.* Here we describe the ways in which dirt gets into a system and precautions that have to be taken to keep it out

THOUGH BEARING DAMAGE can be minimized by reducing the size of dirt particles in the oil, by far the best, and ultimately the cheapest, way to prevent bearing damage is to keep dirt out of the lubricating oil system altogether. So the next question is how this can best be done.

If we start with the knowledge that the lubricating oil leaves the refinery without any dirt in it, there are four stages in which dirt is most likely to enter a lubrication system. These stages will now be considered in detail.

1. Dirt entering during manufacture:
Prevention: Obviously the maintenance engineer has little or no control over the dirt entering the machine components during manufacture. However, most manufacturers take very stringent precautions to ensure absolute cleanliness of their products, and it can be taken as a general rule that when machine components leave a manufacturer's plant they are free of contamination.

2. Dirt entering during construction and during installation of machine:
Prevention: Here again the maintenance man has little control over dirt entering at this stage, since the manufacturer who makes the machine and the contractor who installs it are the people responsible. All the maintenance man can do at this stage is to keep a close watch on the installation procedure and make sure the lubrication system is completely flushed out before acceptance. Also he needs to employ a reliable contractor and be sure that the contract calls for complete cleaning and flushing of the system before acceptance, with careful attention to cleanliness during assembly.

3. Dirt entering during normal operation: From here on the responsibility rests with the operating and maintenance personnel. Here are 4 types of contamination and ways in which contaminants can enter the system during normal operation, with preventive methods to be taken:

a. Contaminant: Fresh water which usually enters from gland steam or from condensation on the inside of machinery housing.

Prevention: Careful regulation of gland steam and continuous use of gland exhausting systems will reduce risk of water contamination from this source.

Condensation is difficult to avoid, and though it can be reduced by insulation in some instances, very often such a step is not practicable, and the most important thing to do then is to keep a close watch on oil filters and strainers, and at the first sign of rust, which indicates the presence of water in the oil, the oil should be changed or cleaned.

b. Contaminant: Dirt which enters during addition of make-up oil.

Prevention: Most contaminants that enter the system while oil is being replenished come from the covers or tops of standing oil drums. Dust, dirt, soot, rust and water are usually present. Drum tops should be carefully wiped clean before drums are opened and vented. The transfer pump should be perfectly clean, particularly the pump suction pipe which is inserted into the drum.

Transfer of oil by applying air pressure to oil drums should be discouraged, for dirt and moisture will be blown into the oil.

The use of wire strainers can give a misleading impression of the size of dirt particles removed from oil. For example, a 60 mesh screen or strainer has 60 wires per linear inch, or 60 times 60 openings per sq in. It is made generally from wire .0075 in. diam. Openings in the strainer will be .009 in. square, and therefore will permit particles of .009 in. or less to pass through. Also the strainer, no matter what size the mesh openings, offers no resistance to entrance by water into the oil. Even if the strainers were as fine as 200 mesh, with openings of .003 in., particles would pass which are *three times* the size of the minimum oil film thickness encountered in the thrust bearings on a typical feed pump, so that bad cutting and scoring of the bearing surfaces would be inevitable.

c. Contaminant: By-products of deterioration of the oil: The best way to avoid danger from this source is to make sure the oil is checked by analysis whenever it is suspected that the useful life of the oil is over.

d. Contaminant: Dirt entering through damaged or improperly cleaned strainers and filters:

Prevention: Strainer basket and filters should be frequently inspected. A hole the size of a pencil in a fine wire-mesh basket will allow contaminant to circulate through the lubricating oil system, leaving a relatively clean strainer and thus giving a false sense of security.

When strainer baskets are inspected they should be removed with great care so that dirt does not fall from them into the strainer housing. Wiping off strainer cover flanges with dirty rags invariably allows dirt to fall into the system. It is also important to clean strainer baskets with perfectly clean solvent. Cleaning a basket in a

*How Dirt Sabotages Your Bearings, POWER ENGINEERING July issue, page 70.

dirty bucket of kerosene can result in dirt being transferred to the lubrication system instead of being removed.

4. Dirt entering during maintenance work: This is probably the way that more dirt gets into the system than any other. Here are a few of the most important precautions that should be taken whenever a lubricating oil system is opened up.

Prevention: All personnel working on the system should have their pockets emptied. Objects commonly carried in shirt pockets are frequently found in damaged oil lubricating systems.

Gratings, catwalks, ladders and platforms located above machinery open for inspection should be closed off as passageways. Very often strict precautions are taken to fence off a working area, but no attention is paid to overhead walkways from which dirt and other particles can fall from shoes of people passing by.

When work is in progress inspection ports and other openings should not be left unattended. All kinds of contaminants, from matches to milk bottles, have a habit of entering lubrication systems through uncovered openings.

Non-absorbent rags and waste should not be used for cleaning. Only clean wiping cloths should be used. Great care should be taken when using wire brushes to scrape the interior of lubricating oil systems since wire bristles break off brushes and must be removed.

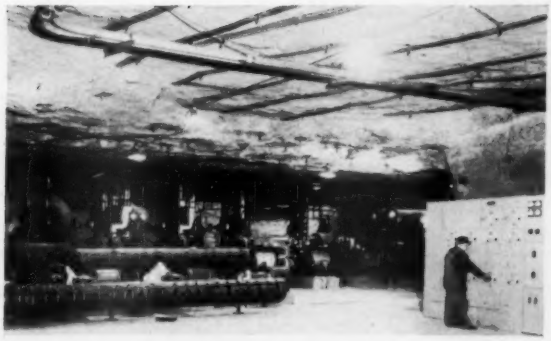
Among the most frequent causes of damage to a lubricating oil system are the pieces of debris from cutting, burning, welding, filing, scraping, and other work done within the sump or gear housing of a lubricating oil system. If the end of a cotter pin, for example, is dropped into the sump and not retrieved immediately, it may one day circulate back and wreck the machine.

Beads of weld splatter are notorious offenders, together with filings and abrasive waste from lapping bearings. All waste must be removed completely. A little extra time spent thoroughly cleaning a machine that has been overhauled will often save a future breakdown.

Contaminants are often introduced into the system during reassembly. To avoid this happening all tools should be wiped clean; old sealing compounds and gasket material should be removed and should not be allowed to enter the system. Gasket punchings should always be removed from bolt holes.

The only certain way to prevent contaminants damaging a lubrication system is to make sure they do not get into the system, and though this requires constant care and vigilance while the machine is open, the effort will be amply repaid in trouble-free operation and the absence of shutdowns due to bearing failures.

The above information is based on an article by George C. Ambler which appeared in a recent issue of the *Bureau of Ships Journal.*



Distribution load center and refrigeration equipment at the Inland Cold Storage plant

This Unique Installation Uses Rigid Steel Conduit

IN A NINE-ACRE underground cave carved out of solid limestone, a unique installation of General Electric rigid steel conduit is used in the first underground freezer of its kind in the United States.

At the Inland Cold Storage Company's freezer warehouse at Kansas City, Kan., built to facilitate interstate movement of frozen foods from the west coast to the eastern markets, G-E White conduit carries the cables from the substation located above ground down through 70 ft of solid stone into the ceiling of worked-out section of former quarry and thence to the distribution load center.

In all, approximately 9½ miles of conduit are used for the electrical distribution system which supplies power for refrigeration equipment for more than 300,000 sq ft of storage space and for the electrical lighting and other electrical equipment.

The storage area in this warehouse can handle 2500 carloads of frozen food. Refrigeration keeps 275,000 sq ft of the area at a constant temperature of minus five degrees F. Another 50,000 sq ft is kept at 32 F.

Serving the freezer warehouse is a railroad spur capable of bringing 18 cars at one time to the loading platforms which are located underground. In addition, a truck dock, at the entrance to the plant, is designed to handle 15 trucks simultaneously.

The G-E White conduit installation is subjected to several extreme conditions. It must withstand alkalis and acids in the soil and rock as it bends down into the former quarry. It must also resist moisture and humidity in the storage and refrigeration areas. In many places conduit is constantly covered with ice.

G-E White rigid conduit runs from the above-ground sub-station (top right) through 70 ft of solid rock to carry power cables to the Inland Cold Storage Warehouse at Kansas City, Kan. At the bottom of the hill is the entrance to the warehouse with the truck loading platform and a railroad spur which carries refrigerated railroad cars deep into the storage area

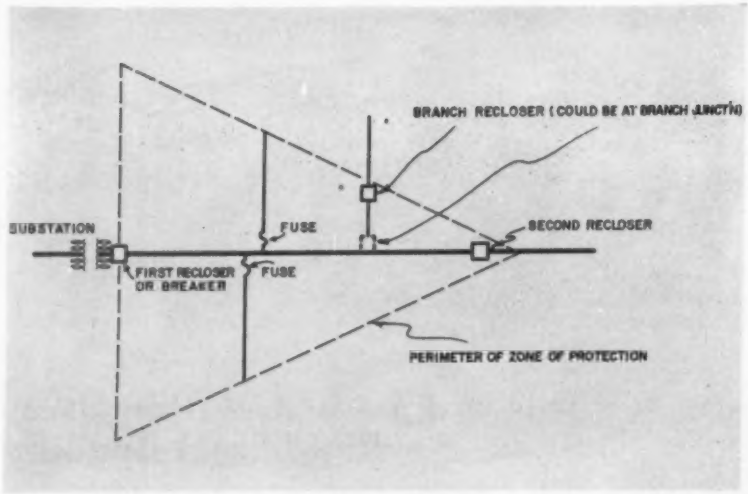


Fig. 1. Zone of protection for recloser or breaker. At perimeter calculated minimum fault current equals min. trip current of recloser or breaker relay

Which Overcurrent Protective System Would You Choose?

Scores of possible combinations make it difficult to choose best protective system for a particular circuit. Here the author systematizes various arrangements and shows how to make the best selection

By G. F. LINCKS*

IN EVALUATING overcurrent protective schemes for distribution circuits three major factors must be considered, namely, 1. Initial cost, 2. Performance, and 3. Operating and maintenance costs.

A higher cost may be justifiable if it improves performance by providing a higher quality service and/or makes possible commensurate reductions in operating or maintenance expenses. However, it is not axiomatic that higher cost equipment provides the greatest benefits. Large economies are possible by properly combining high and low initial cost equipments to provide equal or better performance in the quality of service rendered and in the reduction of expenses.

The overcurrent protective devices available for distribution circuits are (a) automatic circuit reclosers in distribution and power classes, (b) sectionalizers, and (c) distribution fuse cutouts. These are given in a decreasing order of initial cost, i.e. reclosers 100 per cent, sectionalizers 37 per cent, and fuse cutouts 12 per cent.

Generally, automatic reclosers are combined with either fuse cutouts or sectionalizers so the reclosers interrupt all non-persistent (temporary) faults without the cutouts or sectionalizers opening. Permanent faults and some temporary faults which persist too long are isolated by the cutouts or sectionalizer so the smallest number of consumers lose service and so the faulted portion of the line can be located quickly. With such combinations the cutouts or sectionalizers are equivalent to the reclosers in the benefits they provide. Also, since they cost so much less, circuits can be sectionalized at more points for the same or less initial expense, thereby further improving the quality of service and reducing restoration expense.

Thus in planning the overcurrent protection on a system, economics dictate that each recloser be permitted to protect as much of the circuit that it is capable of protecting, which we will call its zone of protection. The perimeter of the zone is determined by the points on the circuit where the calculated minimum fault current equals the minimum tripping current for the recloser. Reclosers used within the zone of protection of another recloser (other than the necessary overlapping to assure protection to the whole circuit) provide no additional benefits.

Figure 1 shows that this zone is triangular with the base at the recloser. Where the feeders or longer branches extend outside of zone of additional protection, additional reclosers should be installed at the perimeter or slightly on the source side.

Fuse cutouts are thermally responsive to overcurrents. Experience has shown they can be coordinated with assurance of 100 per cent correct sequential operation over many years of service. Sectionalizers have series coils with mechanisms for counting sequential overcurrent impulses which are cleared by the associated recloser. They drop open after the second or third impulse has been cleared.

Reclosers are available with different operating cycles or functions in order to provide the desired combined operation with cutouts or sectionalizers. There are two basic functions, 1. Reclosers which hold closed until the fault is isolated by a cutout after opening the circuit instantly once or twice, and 2. Reclosers which open four times and then lock open.

In the latter function reclosers are available with 0 to 3 instantaneous openings followed by time delay openings to complete the cycle of four to lockout. Generally two instantaneous openings are used to clear non-persistent faults before lines burn down and for the best coordination with fuse cutouts. However, where sectionalizers are used, four time-delay openings provide the best assurance that fuses will clear faulted transformers before the sectionalizers drop open even though initial instantaneous opening is preferable for preventing line burn down.

To choose the best combination of reclosers with cutouts or sectionalizers it is advisable to consider all of the factors covered in Tables I, II

* General Electric Co., Schenectady, N. Y.

and III. Table I compares the relative operating advantages from the standpoint of different operating requirements. Table II uses published selling prices and assumed operating and maintenance costs to compare the overall costs of different combinations. Once the equipment has been paid for, the comparison would involve only the relative maintenance and operating costs. While the coordination study is not a recurring cost if normal future growth is factored in the original study, Table III permits comparing the combinations as to the relative ease of making coordination studies.

Maintenance costs are an important item of expense with reclosers and sectionalizers. They must be removed periodically for inspection and drying out of moisture. Also recloser contacts become burned after a number of operations. The standards specify a duty cycle test for all types of reclosers. In service those which open four times to lockout on

Table I. Comparison between operating advantages of several commonly used distribution overcurrent protective systems

Condition	Single Element Fuse Cutouts Only	Single Phase Reclosers Only	Recloser—Fuse Coordination		Recloser—Sectionalizers (Coord.)	
			2 Instantaneous Openings Plus Hold Closed Function of Recloser	2 Instantaneous Plus 2 Time-Delay Openings of Recloser	2 Instantaneous Plus 2 Time-Delay Openings of Recloser	4 Time-Delay Openings of Recloser
1. Outages caused by temporary faults on line.	Cannot differentiate; all faults isolated to faulted portion of circuits.	All line faults cleared with only a momentary outage.				
2. Outages caused by permanent faults on line.		All line faults isolated to faulted portion of circuit. (The number of consumers losing service depends on the ability to sectionalize the primary lines and to coordinate with transformer fuses.)				
3. Ability to sectionalize primary lines.	Can provide selectivity between maximum number of section points in series and to wide range of fault currents.	Limited by number of different ratings available (neglecting limitation by cost).	Selectivity same as for cutouts with 3 to 4 fuses per recloser.	Selectivity limited to 1 to 3 fuses per recloser depending on characteristics of recloser.	Selectivity limited to 2 sectionalizers per recloser.	
4. Ability to sectionalize feeder and long branches within zone of protection of breaker or recloser.	*Not involved.* As fuse or recloser used.		*Can use one or two fuses* plus fuses in branches and subbranches. Beneficial for isolating troublesome sections or indicating if fault is in inaccessible sections.	*Most Use Recloser* At greatly increased cost without commensurate benefit in improving service continuity or reducing restoration expense.		
5. Ability to coordinate with transformer fuse.	Can provide Selectivity with all transformer fuses.	(Provided it has time delayed function.)			Sectionalizer may open first or simultaneously with fuse where transformer fuses do not clear ahead of instantaneous openings of recloser.	Provides time-delay on initial opening of recloser to permit most transformer fuses to clear before sectionalizer drops open.
6. Ability to coordinate with source side fuses or breakers.	Similarity of characteristics permits providing selectivity with the greatest number of ratings.	Inverse time-current characteristics. Limits selectivity with fuses requiring high fusing.	Similarity of cutout characteristic permits providing selectivity with the greatest number of ratings.	Inverse time-current characteristics of recloser limits selectivity with fuses requiring higher source side fusing.		4 time delayed openings limits selectivity further & high fuse or breaker setting.
7. Ability to pick up load following prolonged outages without locking our circuit.	Fuse ratings at section points are high enough to pick up load except in extreme cases.	Will lock out circuit in some cases.	Recloser may hold closed-out fuse ratings high enough to pick up load except in extreme cases.	Recloser will lock out circuit in some cases.	Reclosers will lock out main feeder in some cases. Sectionalizers in all heavily loaded branches or in feeder will drop open after 2 or 3 openings of recloser-requiring manual reclosing to restore service.	4 time delay openings will limit this.
8. Ability to prevent faults from burning down primary lines.	Number of cases of line burndown will increase with fuse rating for a given conductor size.	Initial 2 instantaneous openings of recloser will prevent a majority of cases of line burndown. (Not accompanied by mechanical breakage.)				Lack of initial instantaneous opening of recloser will increase number of cases of line burndown.
9. Ability to withstand lightning without causing outages.	Not over 5% fuse blowing at sectionalizing points on primary lines.	Will not cause outages.	Not over 5% fuse blowing at sectionalizing points on primary lines without lightning protection.		Will not cause outages.	
10. Maintenance required.	Practically zero over many years of life.	Periodically (every 2 to 3 years) must be taken into shop to renew contacts and to remove moisture.	Only reclosers require periodic removal and replacement of contacts and removal of moisture. Contact burning lower as subject to 25 to 50% of fewer operations.		Both recloser and sectionalizers must receive periodic maintenance (every 2 to 3 years) in shop to renew contacts and remove moisture.	

persistent faults are subjected to twice as many operations as the hold-closed design under similar fault conditions. However, since many faults are cleared before lockout, the actual duty cycle on the hold-closed recloser in service is in the neighborhood of 75 per cent as severe as on those which lock open. Generally fuse cutouts are installed and forgotten until a fuse blows and then are given only a superficial inspection, if any.

A good criterion is to choose the combination of protective devices:

1. That provides the highest quality of service (lowest consumer hours outage) for the whole system, by:
(a) assuming 100 per cent correct operation since improper sequence of opening of the circuit is worse when sectionalizing is expected than without it.
(b) providing flexibility to meet varying system requirements as to magnitude and spread of the range of minimum to maximum fault currents.
(c) permitting the sectionalizing of the circuits, considering limitations both by characteristics and costs, so troublesome areas are isolated with a minimum of consumers being affected; whether these areas are on the main feeders, branches, sub-branches or in the distribution transformers and whether 1, 2, 3, 4 or more protective devices must be connected in series with each recloser.

Experimental coordination studies on two or three circuits with a different combination will aid in determining which one permits achieving the desired degree of sectionalizing on the feeder, branches and sub-branches.

2. That reduces the difficulties, time and expense for restoring service after each outage by:
(a) Aiding quick location of faults.
(b) Permitting the backing up of appliance motor loads where diversity has been lost during the outage.
(c) Minimizing the number of line burn downs.

3. With the lowest overall cost (initial, operating, maintenance) which best fulfills the requisite of 1 and 2.

4. With a minimum requirement in time and effort to make the coordination study both initially and in the future, such as for adding branches or transformers.

For example: Table III shows all combinations to require equal time and effort for applying the reclosers. The instantaneous plus time-delay recloser-fuse combination requires more calculations and checking than the others. The hold-closed recloser-fuse combination requires more calculations and checking of ratings to apply the fuses at points on the primary line but this is offset by the equal or greater number of calculations and

Table II. Compares the initial, operating, and maintenance costs for several distribution overcurrent protective systems

Condition	Single Element Fuse Cutouts Only	Single Phase Reclosers Only		Recloser—Fuse Coordination				Recloser-Sectionalizers (Coord.)			
				2 Instantaneous Openings Plus Hold Closed Function of Recloser		2 Instantaneous Plus 2 Time-Delay Openings of Recloser		2 Instantaneous Plus 2 Time-Delay Openings of Recloser		4 Time-Delay Openings of Recloser	
Per Unit Costs		Dist. Recloser	Pwr. Recloser	Dist. Recloser	Pwr. Recloser	Dist. Recloser	Pwr. Recloser	Dist. Recloser	Pwr. Recloser	Dist. Recloser	Pwr. Recloser
Initial[f]	Cutout[c] $18.40 Fuse Link .60	$ 162	$ 285	$ — —	$ — —	$ — —	$ — —	$ Sectionalizer only $60.00			
Yearly Maintenance	0	10 (once every 3 yrs.)	10	— —	— —	— —	— —	Sectionalizer only $10.00			
Total Circuit Costs (3) 3o Section Points — —Recloser — —Fuse — —Sectionalizer	1 2 3	1 2 3		1 2 3		1 2 3		1 2 3		1 2 3	
Initial											
On feeder	$171	$1458	$2565	$1143	$1881	$1458	$2565	$1458	$2563	$1458	$2563
10 branches or sub-bran.	190	1620	2850	190	190	190	190	600	600	600	600
Yearly Maintenance	0	190	190	60*	60*	90	90	190	190	190	190
2% Fuse *Replacement Cost* (Travel & mileage costs the same so not included)	2.39	0	0	2.39	2.39	2.28	2.28	0	0	0	0
5% Fuse Blowing by lightning ($12 per trip & 60c per fuse)	12	0	0	12	12	10	10	0	0	0	0
Total Cost	$375	$3268	$5601	$1407	$2145	$1750	$2857	$2248	$3353	$2248	$3353
Percent of cost of hold closed Recloser-fuse combination #											
Initial cost	27.0%	230%	262%	100#	100#	123%	133%	154%	153%	154%	153%
Initial operating maintenance cost (10 branches)	28.6%	233%	261%	100#	100#	124%	133%	160%	164%	160%	164%
Same only with 20 branches	30.8%	337%	318%	100#	100#	123%	132%	174%	166%	174%	166%

* For 6 reclosers—the 25% lighter duty cycle in service is not factored in these values.
\# Chosen as basis for comparison since it is the lowest cost combination.
[c] Open Type 7.8 kv—100 amp cutout.
[f] Published prices as of January 1956.

checks with either recloser-sectionalizer combination to assure the transformer fuses clear before the sectionalizers drop open. Future branch or transformer additions can be made with no checking with the hold-closed recloser-fuse combination only checking the minimum fault current values at new larger sizes of transformers with the instantaneous time-delay reclosers and fuses and checking both minimum and maximum current values where new larger sizes of transformers are added with the recloser-sectionalizer combinations. When applying any of the combinations, use each recloser so it protects its full zone of protection, and then, because of the recloser's high initial and maintenance costs, use the lower cost fuse cutouts or sectionalizers for the many applications within the zone.

WOULD YOU LIKE TEAR SHEETS?

Readers wanting tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue—Editors.

Table III. Comparison between coordination procedures for several overcurrent protective systems for distribution circuits

Steps In Procedure	Single Element Fuse Cutouts Only	Single Phase Reclosers Only	Recloser—Fuse Coordination		Recloser-Sectionalizer Coordination
			2 Instantaneous Openings Plus Hold Closed Function of Recloser	2 Instantaneous Plus 2 Time-Delay Openings of Recloser	2 Inst. & Time-Delay or 4 Time-Delay Openings of Recloser
I. *Fault current calculations.* (a) *For Reclosers* (1) To locate and coordinate. (2) To assure all fault will be isolated.	(1) and (2) Do not apply	(1) Maximum and minimum values to assure interrupting not exceeded and to determine end of zone of protection along feeder or long branches of each recloser for locating next recloser. (2) Minimum values at ends of all branches and end of feeder to establish zone of protection of each recloser.			
(b) *For Additional Sectionalizing points in feeder branches and sub-branches.* (1) To provide proper coordination.	(1) Max. or Min. values.	(2) No additional values for reclosers located within zone of protection of another recloser.	(2) Max. values only to divide circuit into sections based on min. fuse rating which will coordinate with recloser. Fuse to fuse coordination based on these values.	(2) Max.-Min. values at practically all points for locating fuses to check coordination with recloser using max. values for fuse to fuse coordination.	(1) No additional values required.
(2) To assure all faults will be isolated.	(2) Min. values only at ends of all branches and feeder.		(2) Min. values only at fuses between recloser. Only a very few additional min. values at large branch fuses:—	(2) A few additional values at large branch fuses:—	(2) No additional values required.
			With 300 second melting currents (given on coordination charts) which exceed the minimum tripping current of the recloser.		
(c) *For transformer fuses.* (1) To coordinate with next sectionalizing or branch device.	(1) Max. values only at the largest transformer, or larger one closer to next sectionalizing or branch fuse.	(1) Min. values only at largest transformer or larger one toward end of branches and section or feeder.	(1) No additional values required.	(1) Min. values only at larger sizes of transformers located near ends of branches or feeder.	(1) Max. & Min. values at all larger sizes of transformers to assure fuses will isolate trans. for all available fault currents during 1st or 2d opening of recloser to assure sectionalizer set to drop open on 2d or 3d opening respectively, will not incorrectly open circuit.
II. *Choosing the proper protecting device.*	Step by step choice of rating from furthest large transformer fuse to branch fuse, to sectionalizing fuses, etc. to substation. Additional sectionalizing points obtained by using lower ratings.	Step by step choice of ratings from substation recloser locating next one toward end of zone of protection of the recloser closer to the substation and checking to assure each recloser will protect to the ends of all branches.	Additional sectionalizing fuses chosen as min. ratings permissible in sections determined in calculations except where higher fusing is dictated by fuse to fuse coordination which is checked using calculated max. values in the section. This permits future additions of branches or transformers without further checking of coordination.	Additional sectionalizing requires choosing fuse ratings with max. and min. values in coordination charts which are greater or less respectively than max. and min. calculated fault currents at fuse location. All fuse to fuse coordination checked using calculated max. fault currents at recloser, sectionalizing or branch fuse points. This permits future addition without further checking of coordination.	Additional sectionalizing requires choosing ratings with min. tripping currents the same as for reclosers protecting the section in which sectionalizer is used. Sectionalizers are set to drop open on either 2d or 3d opening of recloser. Transformer fuse to sectionalizer coordination checked by making sure fuses clear before 1st or 2d opening of recloser for full range of fault current with fuses at larger sizes of transformers.

SAFETY AND TIME-SAVING IDEAS FOR TURBINE

THE WORKING PLATFORM

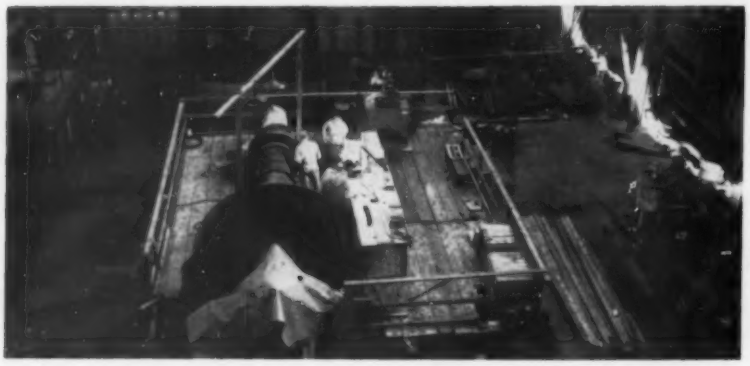


Fig. 1. Shows the large strongly built temporary working platform used for maintenance work on the turbine spindle

Fig. 2. Wide and strongly built steps up to the working platform cost little in lumber and help to prevent accidents

This is the seventeenth, and last, article in a series describing the scheduled overhaul of a 25,000 kw turbine generator at U. S. Steel Corp.'s South Works in Chicago. The whole series will now be reprinted. To reserve reprint copies, write to the Editor

MANY READERS faced with this type of overhaul would be tempted to save money by building small temporary platforms for work on the spindle and the turbine cover. This would be false economy. Money spent on a large sturdy platform, as shown in Figs. 1 and 2, is saved many times over during an overhaul. With this type of platform men could work freely and safely. There was plenty of room for tools and equipment, and when an unexpected emergency arose, such as the need to metallize part of the turbine shaft (as described in the Sept. '55 issue of POWER ENGINEERING) the existing platform was found to be quite adequate for the job without any extra construction or alterations being necessary.

The same lumber was used over again on other maintenance jobs.

VACUUM CLEANING

Fig. 3. A vacuum cleaner was in continuous use around the machine to pick up scraps and dust during the overhaul

A VACUUM CLEANER was in continuous use in and around the machine during overhaul and reassembly. A vacuum cleaner will pick up particles from places inaccessible to wiping towels, and the cost of the cleaner and the labor to operate it were more than repaid by the cleanliness of the machine during reassembly. Figure 3 shows bits of lagging and dust being removed from one of the main valves before the linkage was replaced.

FIRE PROTECTION

IN ADDITION to a large foam set (Fig. 4) kept on the job throughout the overhaul, cylinders of CO_2 type "B" size 20 fire extinguishers were also kept available around the machine for putting out small fires before they could grow.

On jobs of this nature minor welding operations have to be done quite frequently, and small blobs of molten metal will smolder if they fall on scaffolding or burlap. These small CO_2 extinguishers are excellent for putting out small fires immediately.

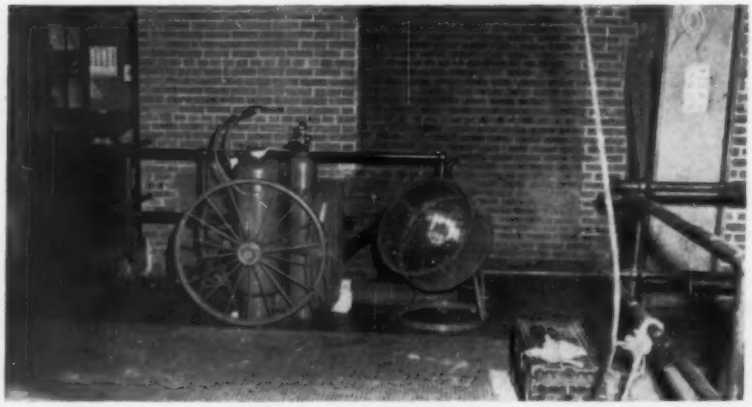


Fig. 4. In addition to this large foam extinguisher, a number of CO_2 cylinders were kept handy on the job to put out any small fires before they could grow

WIPING TOWELS

Fig. 5. Plenty of wiping towels are essential during an overhaul. Clean towels were always available in this bin

AN ADEQUATE supply of clean wiping towels is essential on any overhaul to make sure all parts are cleaned thoroughly before reassembly. For this particular job, two bins were provided, one for clean towels and one for dirty ones. The clean towel bin was kept replenished from the power plant storeroom, while dirty towels were sent out to be washed and returned. With this system the total cost of rags for the whole month came to approximately $35.00, which was money well spent in terms of clean and efficient reassembly with no time wasted by men having to hunt around for clean towels.

COMPARTMENTED BOX

IN THE NINTH article in this series (POWER ENGINEERING Dec. '55) we described how blade clearances were checked by placing strips of lead on each row of blades and between blade rows on spindle and casing and then measuring the indentations in the lead after cover and spindle had been removed. Since there were 68 rows of blades on this machine, 272 strips of lead had to be removed and measured each time clearances were checked. To avoid confusion, a compartmented box to hold these strips was made out of plywood. It is shown in Fig. 6, which shows that each compartment is numbered to correspond to a blading row. As each strip of lead was removed from the turbine it was placed in its appropriate compartment until it was ready to be measured and recorded. Without such an arrangement it is very easy for some of the lead strips to get mixed up or lost during the operation.

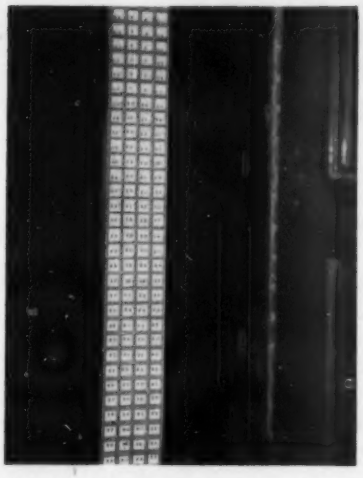


Fig. 6. Shows compartmented box to hold lead strips used for checking turbine blade clearances. Compartment numbers correspond to rows of blades

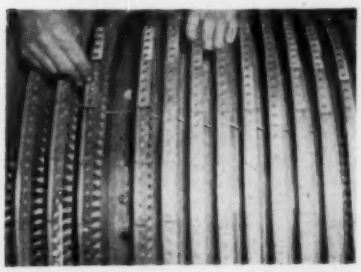


Fig. 7. Turbine had 68 rows of blading, so 272 pieces of lead had to be measured each time clearances were checked

SAFETY INSTRUCTIONS FOR TURBINE GENERATOR OVERHAUL

BEFORE the job started, a set of safety rules was issued to every man connected with the overhaul. These rules are shown below. Though overhauls in other plants will need special rules to suit their own conditions, this list provides a good basis for making a set of safety regulations for any similar overhaul operation.

1. Always keep in mind that someone may be working above or below you. Rope off areas below and above your area of work.

2. Be especially careful about leaving tools and equipment where they may slide off or be kicked onto someone below.

3. Practice good housekeeping. Keep walkways and working areas clean and free of tripping hazards.

4. Cover all openings whenever possible to prevent material from dropping into them.

5. Some of the piping may be hot. Approach piping carefully and use asbestos gloves if it is hot.

6. Do not break any lines before being absolutely sure they are dead. Then loosen the joint with care.

7. Be sure all wrenches, slings and other tools are in good condition.

8. Be sure of your footing when sledging or pulling on wrenches. Be especially careful to see that the wrenches do not slip.

9. Be careful of sharp edges when cleaning the turbine spindle. Wear gloves to protect your hands.

10. Be careful not to drop anything into the turbine casing. Report anything which has been dropped immediately, as it *must* be found before units are assembled.

11. Wear goggles when using buffing wheel or air hose.

12. Wipe up all spilled oil immediately to minimize the slipping hazard.

13. Make all hitches and cribbing with care. Be sure the sling used is large enough for the lift you intend to make.

14. The craneman will take lift, lower and movement signals from one man only. He will take a stop signal from anyone.

15. All men working on the turbine must keep their shirt and jacket pockets free of any article which might drop out of them into the turbine and go unnoticed.

TOOL FOR HANDLING BALANCE WEIGHTS

Fig. 8. Arrow shows balance weight being inserted through hole in turbine casing

IN THE ELEVENTH article of this series (POWER ENGINEERING Feb. '55) we explained how additional balance weights were added to the turbine spindle through a hole in the casing. It would obviously be disastrous if one of these balance weights fell into the turbine body while it was being installed, since the only way to get it out would be to unbolt the cover and remove both cover and spindle — slow and expensive operations. The tool shown in Figs. 8 and 9 enabled this job to be done without hazard.

The balance weights were pieces of $\frac{7}{8}$ in. dia steel, about 3 in. long, threaded their whole length. At one end they had a screwdriver slot. The tool consisted of a tube, threaded at one end internally to fit the balance weight, and a steel rod with a screwdriver flat at one end and a hexagonal head at the other.

Method of operation was as follows: The balance weight to be installed was threaded part way into the tube, and the screwdriver rod was put into the tube as shown in Fig. 9. Then the balance weight was passed through the hole in the turbine casing and screwed into the spindle by means of a wrench used on the hexagonal head of the screwdriver rod. Then both tube and rod were withdrawn, leaving the balance weight in position in the spindle.

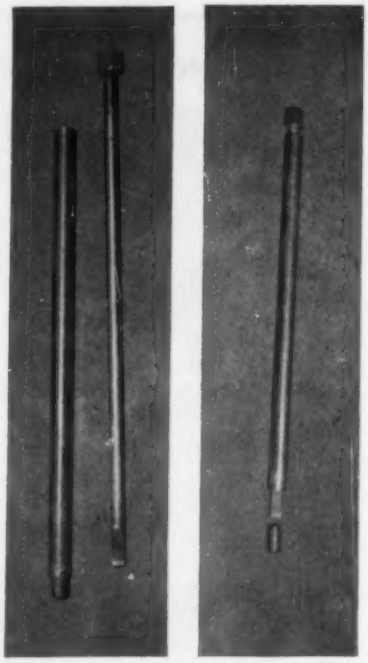
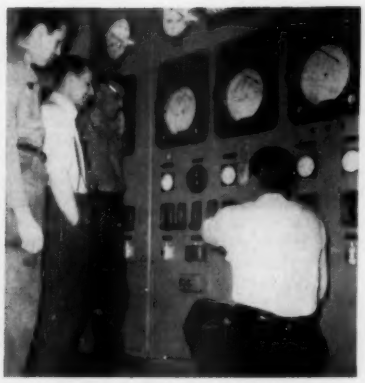


Fig. 9. Two views of tool used to insert balance weights into turbine spindle without risk of dropping weights and having to open up turbine to find them

This is the last article in our turbine overhaul series. The whole series is now being reprinted, and will form a 48-page booklet. If you want one or more copies of the reprint write to the Editor, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Illinois.

Here are the titles of the articles making up the reprint:—Planning . . . Preparation . . . Preliminary work; Removing turbine cover and spindle; Turning turbine cover; Reblading; Metallizing turbine shaft; Machining turbine spindle; Electrical inspection and testing; Pulling generator rotor—Parts I and II; Adjusting bearing pads; Balancing; Overhauling auxiliary equipment—Parts I and II; Safety and time-saving ideas—Parts I and II.



Figs. 1, 2, and 3. When training a steam plant crew, have the men learn by doing. A good program to follow goes like this: "Tell 'em how, show 'em how, make 'em do it!" Here, men learn valve operation, pump starting, controls

How We Instructed a New Steam Plant Crew

There's an old saying in the trade that a power engineer can do anything—if he has to. Here's an example of that versatility. Faced with the need to break in a new crew, this power engineer conceived a program, organized courses, and became an instructor

By G. R. SETTERLUND

WHEN OUR COMPANY began building a new steam plant for additional capacity at another location, we were confronted — as so many of us are these days — with the necessity of training an entire crew to operate, what was to them, strange new equipment. Our chief concern was the time available to us for instruction — could we do a proper job of teaching practically untrained men to handle the plant in the few months that remained before it was to go on the line?

Thanks to the wholehearted cooperation of the engineering and supervisory staff, we were able to move the crew in, light off the plant, and operate it without a hitch after a relatively short course of planned instruction.

Planned Instruction Is Key

We believe that whatever success we achieved can be attributed to the words, "planned instruction." Here, then, for what it may be worth to others who may not yet have had such experience, is the way we did it.

The first step we took in planning the instruction was to determine how much time would be, or should be available for the various phases of the project. This in turn fixed the extent of preparation we were able to make. As it developed, preparation time was decidedly limited in view of the time we wanted to devote to actual instruction.

Next step was to break down the new plant into a logical sequence of easy-to-handle segments. This plant was to consist of a pulverized-coal-burning unit, designed to provide 175,000 pounds of steam at 650 psig, 700 F, using feedwater at 310 F. Coal would be supplied by a single ball mill with two FW exhausters and four burners; a conveyor system supplied the single boiler with coal, and equipment was furnished to remove the ash. Make-up water was supplied by split-stream ion-exchange water softeners.

We decided to start the instruction course with the water source, following it through filters, softeners, storage, feedwater deareator heaters, feedwater control lines, into the boiler, and finally out as steam.

Next came firing, starting with receipt of the coal and following it through the conveyor systems to the bunkers feeders, pulverizer exhausters, and so into the burners and furnace. The combustion sequence followed naturally.

One sequence remained — the control sequence. Mock-up panels are ideal for this, but drawings made to look as close to the real thing as possible can also be used.

Simplified Drawings Made

When the general pattern of instruction was laid out, individual study papers were prepared for each set, or piece of equipment. The resident engineer spent many an evening poring over the volumes of equipment information on hand, making up brief but complete lists of capacities, operational methods, and special instructions. Wherever possible, simplified drawings were made of systems and parts of systems to amplify the instructions.

It should be noted here that we did not consider engineering blueprints — in general — as suitable material for instructing our operators. Not many of the men were skilled in interpreting such drawings correctly, and we believed the time spent in translating them into simple isometric drawings would be much less than that required to teach them to read blueprints. Furthermore, by so doing, we eliminated the psychological resistance that might otherwise attend the introduction of untrained personnel to complex engineering prints. Some of these drawings, of course, were of a nature that permitted ready understanding and could be used without fear of confusing anyone.

Ici On Parle Français

An additional hurdle we had to face was the fact that many of our operators were French Canadians who were not too familiar with English. This difficulty was resolved by a bilingual foreman who translated all the essential instructions into French for their benefit. Each instruction sheet carried the important message in both languages (see Figs. 4 and 5).

A sufficient number of white prints were made of the whole set of study papers and related drawings, then assembled into binders — one for each of the prospective crewmen. These books served as texts for private study and as outlines for group instruction.

When all the instruction material was prepared and reviewed, our next step was to draw up the schedule of instruction. Certain preliminary phases of the work were to be handled

by the plant superintendent, who would personally instruct individual crewmen according to the lesson plans. Other phases were to be handled by other individuals on a group basis; these included blackboard lectures, conducted tours at the plant site, etc.

Each of these activities were carefully scheduled to fit into the duty hours of the individuals involved. We made sure that the men selected for a particular lecture or tour would be available at that particular time, and the schedule was planned accordingly. Then came a "dry run" over the course — concentrating on the system tours — to be sure that the time allotted was adequate to cover the subject at hand. With all of these preliminaries out of the way, we were ready to go.

The first step in the training course was in the nature of a briefing. The men were called together and the general plan of training was outlined for them so they would know what to expect from the course and how it would be run. The new plant was described, its features explained, and study books handed out.

We kept the meeting informal and used several speakers to put over the points that were to be made. This part of the briefing over, the meeting was thrown open to questions — and we got a lot of them. Only general questions were entertained; specific questions about plant operation were deferred for that part of the course that would cover them. Next step was the actual instruction.

Here, as an example, is how a system "tour" was begun. At 9 A.M. on the allotted day I met five of our potential crewmen and we proceeded to the water source — the river bank. (We had decided that five or six men was an optimum group for this type of instruction.) Standing on the bank of a fast-flowing river on a warm spring morning is conducive to a relaxed approach and it was natural to start the talk in a conversational vein — like this:

"Well, fellows, today we start on the actual operational instructions for our new steam plant. We're going to start right here — the beginning of the water system — and gradually work our way through all the systems until we finally come to the day when we can flash off the burners.

"We will go slowly to give everyone a chance to understand what we're going to see, to think of questions and get them answered. And speaking of questions — don't hesitate about asking them . . . you know, lots of times people won't ask questions because they're afraid other people will think them stupid for not understanding. Actually, chances are that if you don't understand something, others may not either — only they don't want to admit it!

"So, ask all the questions you can think of — you'll probably be helping somebody else without knowing it.

"One final remark about questions — you will probably ask some questions that I can't answer. If you do, I'll make a note of them and look up the answers later — in that way we'll both learn something we didn't know before. Okay? Avez-vous des questions? Well then, let's get started!"

To give the men a sense of personal participation in the operations of the plant, we tried to have each one of them see, feel, taste, or smell what was happening in, for example, the water system. I dipped out a beakerfull of water from the river and passed it around the group.

"Take a look at the water in that beaker. See the innumerable small particles of silt and dirt floating around in there? We certainly don't want that stuff in our boilers.

"Now, the question is, how do we get such fine particles out of the water — the answer is that we make them into big particles that will sink. This is done by a process called "coagulation," which is just a name for a method of causing a lot of fine particles to lump together to make fewer large clumps. Over here, you'll see how alum is fed into the incoming stream. See how that alum is causing the appearance of flakes. . . ."

And so on. As we progressed through the system, frequent reference was made to the diagrams in their study book that pertained to

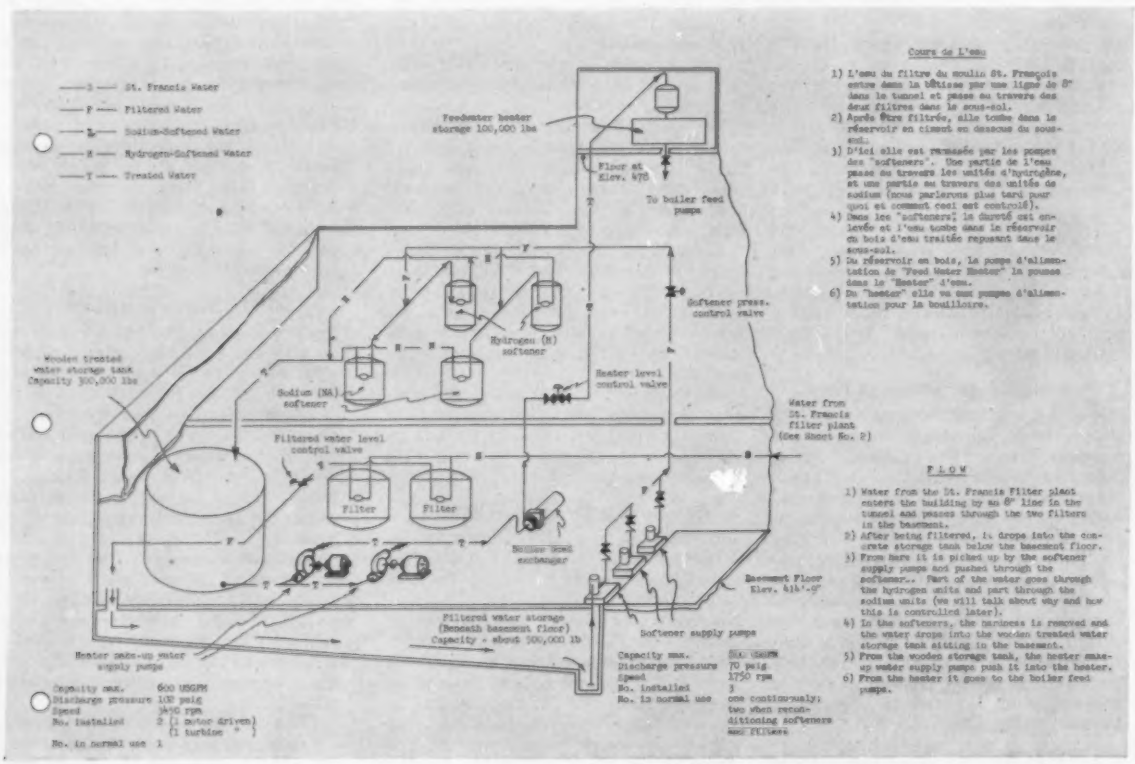

Cours de l'eau
1) L'eau du filtre du moulin St. François entre dans la bâtisse par une ligne de 8" dans le tunnel et passe au travers des deux filtres dans le sous-sol.
2) Après être filtrée, elle tombe dans le réservoir en ciment en dessous du sous-sol.
3) D'ici elle est ramassée par les pompes des "softeners". Une partie de l'eau passe au travers les unités d'hydrogène, et une partie au travers des unités de sodium (nous parlerons plus tard pour quoi et comment ceci est contrôlé).
4) Dans les "softeners", la dureté est enlevée et l'eau tombe dans le réservoir en bois d'eau traitée reposant dans le sous-sol.
5) Du réservoir en bois, la pompe d'alimentation de "Feed Water Heater" la pousse dans le "Heater" d'eau.
6) Du "heater" elle va aux pompes d'alimentation pour la bouilloire.
FLOW
1) Water from the St. Francis Filter plant enters the building by an 8" line in the tunnel and passes through the two filters in the basement.
2) After being filtered, it drops into the concrete storage tank below the basement floor.
3) From here it is picked up by the softener supply pumps and pushed through the softener.. Part of the water goes through the hydrogen units and part through the sodium units (we will talk about why and how this is controlled later).
4) In the softeners, the hardness is removed and the water drops into the wooden treated water storage tank sitting in the basement.
5) From the wooden storage tank, the heater make-up water supply pumps push it into the heater.
6) From the heater it goes to the boiler feed pumps.
—S— St. Francis Water
—F— Filtered Water
—Na— Sodium-Softened Water
—H— Hydrogen-Softened Water
—T— Treated Water
Feedwater heater storage 100,000 lbs
Floor at Elev. 478
To boiler feed pumps
Softener press. control valve
Hydrogen (H) softener
Sodium (Na) softener
Heater level control valve
Wooden treated water storage tank Capacity 300,000 lbs
Water from St. Francis filter plant (See Sheet No. 2)
Filtered water level control valve
Filter
Filter
Boiler feed exchanger
Basement Floor Elev. 434'-0"
Filtered water storage (Beneath basement floor) Capacity - about 500,000 lb
Softener supply pumps
Heater make-up water supply pumps
Capacity max. 600 USGPM
Discharge pressure 100 psig
Speed 1440 rpm
No. installed 2 (1 motor driven) (1 turbine ")
No. in normal use 1
Capacity max. 600 USGPM
Discharge pressure 70 psig
Speed 1750 rpm
No. installed 3
No. in normal use one continuously; two when reconditioning softeners and filters

Fig. 4. Men may have difficulty visualizing engineering blueprints; simple isometric drawing of system like this makes it much easier to understand. Note bilingual text for French-Canadians who might have trouble with English

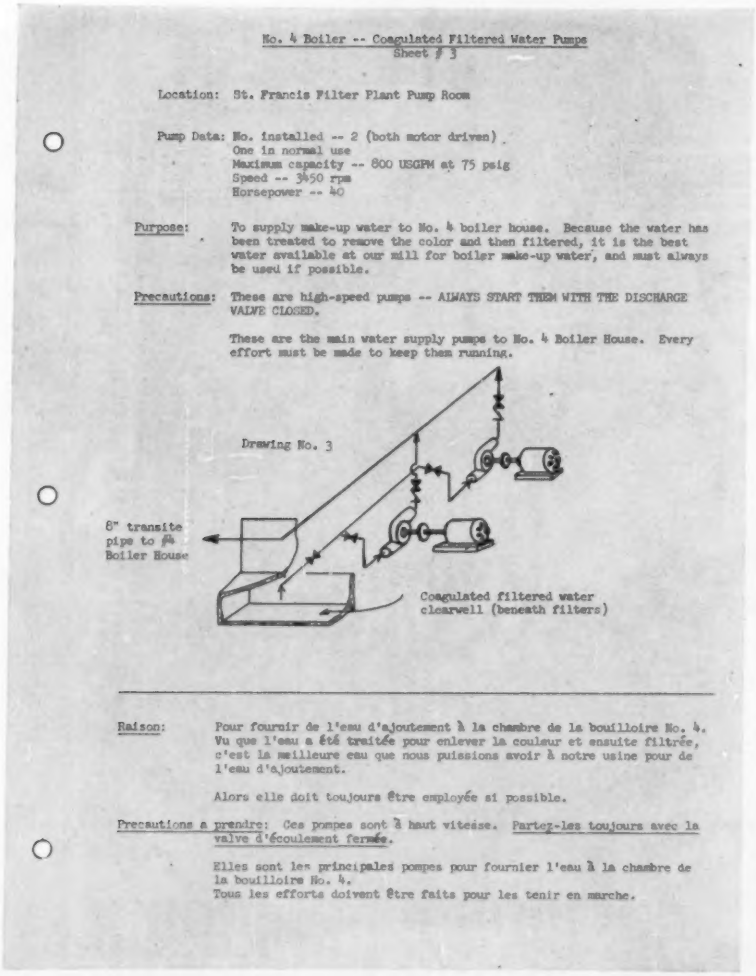

No. 4 Boiler -- Coagulated Filtered Water Pumps
Sheet # 3
Location: St. Francis Filter Plant Pump Room
Pump Data: No. installed -- 2 (both motor driven)
One in normal use
Maximum capacity -- 800 USGPM at 75 psig
Speed -- 3450 rpm
Horsepower -- 40
Purpose: To supply make-up water to No. 4 boiler house. Because the water has been treated to remove the color and then filtered, it is the best water available at our mill for boiler make-up water, and must always be used if possible.
Precautions: These are high-speed pumps -- ALWAYS START THEM WITH THE DISCHARGE VALVE CLOSED.
These are the main water supply pumps to No. 4 Boiler House. Every effort must be made to keep them running.
Drawing No. 3
8" transite pipe to #4 Boiler House
Coagulated filtered water clearwell (beneath filters)
Raison: Pour fournir de l'eau d'ajoutement à la chambre de la bouilloire No. 4. Vu que l'eau a été traitée pour enlever la couleur et ensuite filtrée, c'est la meilleure eau que nous puissions avoir à notre usine pour de l'eau d'ajoutement.
Alors elle doit toujours être employée si possible.
Precautions a prendre: Ces pompes sont à haut vitesse. Partez-les toujours avec la valve d'écoulement fermée.
Elles sont les principales pompes pour fournier l'eau à la chambre de la bouilloire No. 4.
Tous les efforts doivent être faits pour les tenir en marche.

Fig. 5. Typical study sheet used in operator training course. All pertinent data and information on these pumps and their use are incorporated on one sheet

the installation we were discussing. This served to give the drawings reality and perspective.

Our "classroom" lectures were conducted in much the same manner, but we kept down the length of instruction time. I believe that the average person who has no background of formal study training can cope with about one half-hour of verbal instruction at a time without becoming restive. Beyond this time, there is a falling off of interest and concentration, so it is best to break up the lesson period into half-hour segments — interspersing the blackboard lectures with instruction of some kind that involves physical participation. For instance, a half-hour discussion might be held about the various types of valves in a given system; this should be followed by a "break" during which the men are taken to the valves in question and actually shown their operation.

It is well known that people learn best by doing. Take advantage of this principle; have each man operate the valve himself. Assume that a particular valve is closed. Point out that fact by asking the question, "Is that valve closed? . . . How can you tell?"

It may seem ridiculous to explain the opening and closing of valves, but many costly errors might have been avoided in the past if the men involved had been so completely familiar with the operation of important equipment that they would have made the right moves automatically and unhesitatingly in an emergency. So don't be afraid to have your students actually open and close valves — any embarrassment that arises will soon disappear as you point out spindle positions, indicators, and directional arrows. Be matter-of-fact about your presentation, and the men will accept your instruction in the same spirit.

Through all of this kind of work, the instructor should constantly bear in mind one thought above all others — particularly when he becomes discouraged with a slow pupil . . . "If the student hasn't learned, the teacher hasn't taught!"

Ice Warms Air in Canadian Mine

WHEN WATER changes into ice, heat is released, and this convenient twist of nature has been put to ingenious use in the Stobie section of the International Nickel Company's mines at Sudbury, Ontario.

Between the 300 ft and 500 ft working levels, two large chambers, known as stopes, have been constructed. Each is 200 ft long by 200 ft high by 80 ft wide. Each stope is equipped with four sprays in the roof, and from these outlet points water at 120 psi is sprayed into the chambers.

Ice Formation

In winter the outside air in the mining area goes down to 25 degrees below zero, and the air for ventilating the working areas passes through the stopes, where it comes in contact with the water sprays. As this cold air passes through the stopes, the fine particles of water in the sprays turn to ice, and the heat given up in the process is transferred to the air. In addition the air picks up more heat from the large area of wall rock exposed in the stopes.

The ice drops to the floor of the stopes and the warm air continues on its way to the working areas.

Last winter some 40,000 tons of ice were formed at the bottom of the stopes, and the total heat picked up by the ventilating air amounted to 15 billion Btu's, or the equivalent of burning 100,000 gal of oil or 850 tons of coal.

Though the air outside mine went down to 25 below zero, the ventilating air in the mine varied only between 27 and 30 degrees above zero as a result of its trip through the stopes. The temperature is expected to be held at about 32 degrees above zero as the system is improved. The volume of water required in the winter months varies up to 200 gal per min, and the fan delivering air to underground has a diam of 198 in. and is one of the largest in the world. It has a top capacity of 750,000 cu ft per min.

Summer Cooling

In summer the ice will be melted as the fresh warm air passes through the stopes, and the air's humidity will also be reduced as it cools below the dew point and much of its moisture is condensed out.

When the volume of air handled through the system ultimately reaches full capacity of 750,000 cu ft per min, as compared with 150,000 to 300,000 cfm during the past winter, upwards of 140,000 tons of ice will be formed in the stopes each winter.

The result of this ingenious use of the properties of freezing water is that the mine is now equipped with a very efficient air conditioning system at a fraction of the cost of a surface heating plant.

Power Engineering handbook

High Pressure Air Soot-Blowing

By G. R. SETTERLUND

PERHAPS YOU HAVE installed high pressure soot-blowers in your plant; or you may now be planning on using them for some installation. Here is a case history where an air system was installed, and experience with it should be of value.

We recently installed a liquor recovery unit, and with its start-up came problems probably common to similar installations. The soot-blowers in the boiler itself, including the economizer section, are of the rotating "puff" type. Each blower rotates and a cam governs the blowing arc. Of course, the positions of the baffles in the furnace dictate the blowing arc. The 28 blowers are divided into three groups, for control purposes. These groups contain roughly the soot-blowers located in each pass of the boiler. Since the unit is very wide, two blowers are located in opposite walls to cover the entire width of the furnace. The elements are nozzled to blow directly between the tube rows.

Since it necessarily follows that the hottest gases lie closest to the combustion chamber, the blower elements in this section and part of the first pass section were made of Dialoy metal. We ran into trouble at the start-up here and, probably because of poor combustion conditions, found that the first section of the boiler main bank, just beyond the screen tubes, would slag in. Due to the intense heat, the Dialoy elements literally disappeared — they would burn out entirely. So the old chicken-or-the-egg question presented itself: did the soot-blowers fail to keep this section clean, or did the elements burn out first? Dialoys are expensive and starting up a new boiler well slagged-up is certainly no asset to production.

By removing the first four blowers entirely and moving them back two rows of tubes, our worries were over. In doing so, we were forced to cut down on the size of the element, and weld hangers on the tubes in a very limited space. (In a similar installation I know of, this same problem was solved by an ingenious system of water-cooled hangers, which saved both hangers and elements.)

Seamless steel elements have now replaced the Dialoys and are perfectly satisfactory. Rolled tubing elements were tried first but ruptured at the joint and resulted in jammed elements impossible to remove during operation. Revamping the master controller by adding additional pilot heads and teeing the group controller enables the first section to be reblown between other groups. In other words, the front section is operated five times during one complete cycle (see Fig. 2). Hand lancing is now completely eliminated except for "test" probing" if draft indicators show an increase of differential beyond comfortable limits across the tubes.

A point to consider here is the piping

fold along this line—outside edges toward you

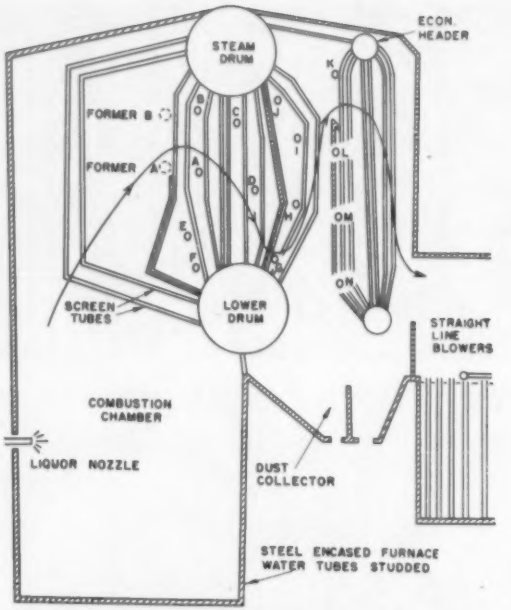


Fig. 1. Pattern of blowing follow flue gas path and direction

layout from the high pressure air banks to the soot-blowers. Provide for an ample supply of shut-off valves so that some units may be removed without interfering with the rest of the units. Although the initial cost is higher, an all-flange system is better than a screwed joint piping layout. Break a screwed joint a couple of times and leaks will inevitably occur. Design these joints at such places that when the joint is broken the remaining piping will not interfere with the removal of the unit.

Since lubrication of the ratchet assemblies is carried out from the master controllers, trouble will result with any rubber components in the system. Neoprene is helpful as far as diaphragms are concerned, but replacing all small check valve assemblies and rubber shut-offs in the control air system with small steel balls and springs will end any "tacky-rubber" stoppages that occur

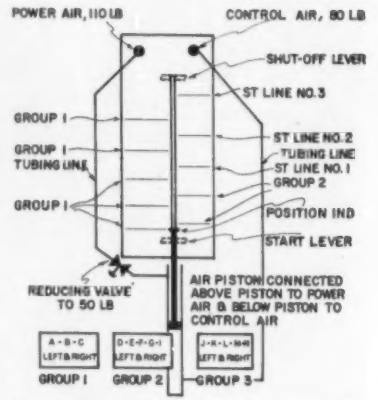


Fig. 2. Schematic showing automatic blowing system

cut along this line

the BIG name in water conditioning is

W. H. & L. D. BETZ, Philadelphia, Pa.

when oil and rubber are in contact.

Anyone having the straight-line type of blowers will appreciate the system even more if ample end-clearance in the housing of the air heater is allowed for. Be sure that the blowers can pass beyond the extreme rows of tubes, both in front and in the rear. Most of the straight-line stoppages will occur because of dust build-up along the tube-header and the walls, and if the blowers could be recessed this build-up could not occur.

A responsible person should check each individual blower every 24 hours to see that each is working properly. Any broken tubing lines, leaking packing glands and faulty turning, and blowing will easily be detected and can be repaired promptly. The value of any soot-blower installation lies in the degree of cleanliness it will afford a boiler.

We use a fully automatic system, even to the re-cycling of the unit (see Fig. 2). When the position indicator reached the top, a trip lever would shut off the entire system. It was necessary for the engineer to note this and reset it. In order to reset the system he would force the position indicator downward, and a reverse-acting trip lever would again direct pressure to the control panel. A simple pneumatic jacking piston was installed between the shut-off and start levers, and a suitable lever now does the work of the engineer and gives him time for other duties. This cylinder cannot forget to reset the system.

Maintenance and supervision of this air soot-blower system is now practically negligible. A complete yearly overhaul of all units assures another year of pleasant confidence and a high interest rate of clean boiler tubes.

Wrong Pipe Connections Can Be Wasteful

By ALBERT H. MOULTON

THERE ARE MANY instances where a little better piping layout would have saved many thousands of dollars in plant operation over the years, with little or no extra investment.

One such case of special interest occurred in a small paper mill. This mill had one paper machine with Fourdrinier drying rolls. The condensate was removed by a vacuum return system using a battery of vacuum pumps. While pumped back to the boiler room where the pumps were located, this condensate was not used for boiler feed. (This is the rule when engine exhaust is used, in order to keep oil from getting back into the boilers and especially into the live steam which comes into direct contact with the stuff in the headbox of the machine.)

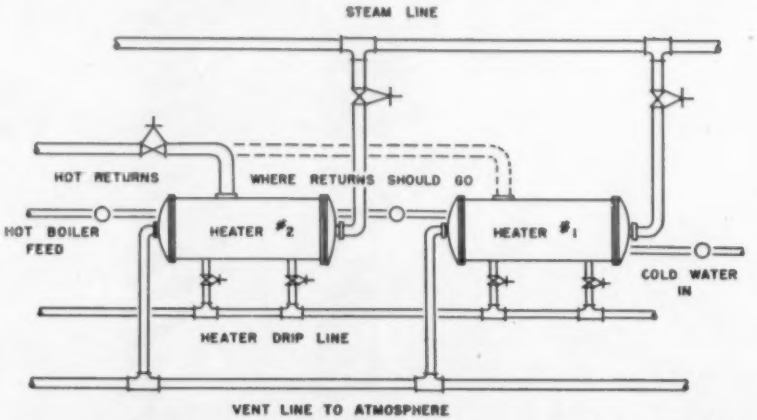
The condensate return flow was 85,000 lb per 24 hours, at an average temperature of 150 deg F. This represented a considerable waste of heat. This condition had been noticed and someone in the plant conceived the idea of using one of the two closed heaters, which were connected in series, as a heat exchanger. The plan was to bring the discharge from the vacuum pumps into the steam side of the No. 2 heater, where it would give up its heat to feed water.

However, the cold feed water was piped to the No. 1 heater and was heated by exhaust or reduced pressure steam to between 170 and 175 deg. Then it ran through the No. 2 heater where it met the 150 deg condensate. Now 150 deg water cannot give up heat to 170 deg water, so the effect was to cool the feed water while the condensate was heated.

Now, if the condensate had been brought to the No. 1 heater, where it would have met the cold feed water, it would have given up most of its heat. But instead, it went to the No. 2 heater where more steam was admitted to bring it up to 190 deg, and mingling with the condensate in the steam side of the heater raised its temperature to 212 deg before it was discharged to the river. But if the returns had been piped to the No. 1 heater, the second heater could have finished heating to the required temperature.

An estimate of the loss per year from this error in piping is significant. Basing the calculation on a daily condensate flow of 85,000 lb at 150 deg, it can be figured that the daily saving in Btu would be 9,027,000, had the condensate given up say 90 per cent of its heat. The boiler efficiency averaged 60 per cent, and the coal had an average heat value of 13,000 Btu per lb. Therefore, the heat that could have been saved was equivalent to 1,060 lb per day, or 159 tons per year.

But instead of this saving, there was a daily loss of 15,300,000 Btu, which is equivalent to 1,800 lb of coal per day, or 270 tons per year; or 111 tons a year could have been saved by running the returns directly to the river (the mill operated about 300 days a year).



If condensate had been brought to No. 1 heater, it would have given up most of its heat, saved costs

CLEVER SHACKLING DEVICE, developed in connection with aircraft operated by Silver City Airways, Ltd., London, England, replaces the screw-type turnbuckle. It has considerably reduced the time taken for loading and unloading of vehicles

VERSATILE NEW STUD DRIVER power actuated, is Remington's model 455. The driver has interchangeable barrels which quickly adapt it to standard or heavy duty jobs. Photo shows tool in action, anchoring a wooden two-by-four to steel upright

fold along this line—outside edges toward you

cut along this line

R.S.M. Design features like these help Edward sell more steel non-return valves than any other manufacturer in the world. B.J.B.

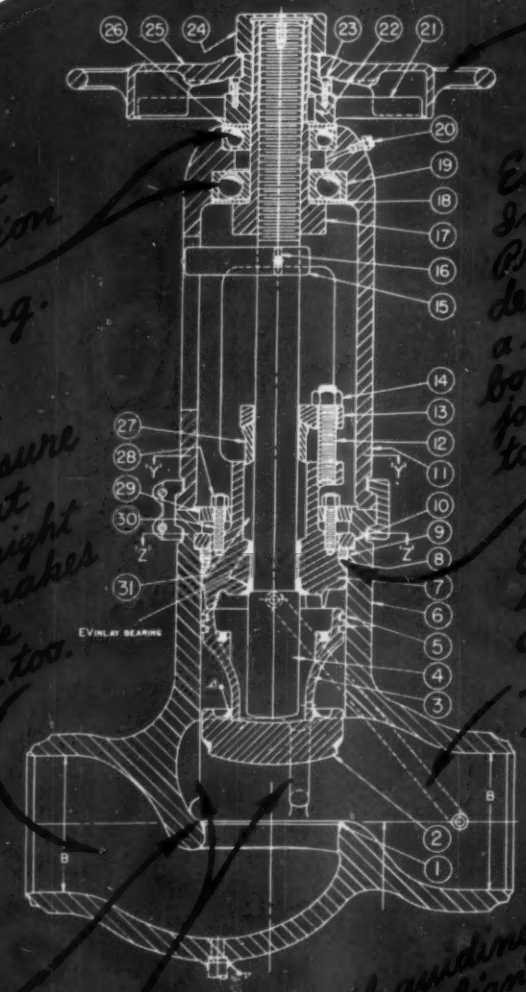
Edward Impactor handwheel seats big valve tightly - allows one man to do the job of three.

ROCKWELL BUILT
Edward Valves

Patented Evalthrust bearing construction eases operation reduces stem drag.

Streamlined body really helps. Pressure drop is only about half what you might guess. Edward streamlined angle non-return valves too.

Integral Stellite seat is best. Only Edward has it on large valves.



Edward Improved Pressure Seal design makes a leak proof bonnet body joint, is easy to disassemble.

Equalizer aids disk-piston lift, reduces motion and extends life of guiding surfaces.

Full length rib guiding of disk provides perfect alignment, insures true seating and reduces danger of hang ups.

When it comes to steel non-return valves, let's order Edward and have them quote on other valves too.

LIST OF MATERIALS
QUANTITIES ARE FOR ONE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED, THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	REQ.	MATERIAL	SPECIFICATIONS	STANDARD WGHT.
1	SEAT	1	STELLITE	INTEGRAL WITH BODY	481
2	DISK	1	FORGED ALLOY STEEL STELLITED	A.S.T.M. A182, GRADE F11	227 481
3	PISTON-WELDED TO DISK	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	102
4	STEM	1	CHROMOLOY	A.S.T.M. A182, GRADE F6	118
5	PISTON RINGS	2	CHROMOLOY	A.S.T.M. A182, GRADE F6	118
6	BODY	1	CAST STEEL C-0.30% MAX.	A.S.T.M. A216, GRADE WCB	1102
			CAST STEEL C-0.20% MAX.	A.S.T.M. A217, GRADE WC6	1176
			CAST STEEL C-.08% MAX.	A.S.T.M. A217, GRADE WC9	1242
7	BONNET	1	CAST STEEL	A.S.T.M. A217, GRADE WCI	1102
8	PRESSURE SEAL GASKET	1	ARMCO IRON	MALLEABLE PLATED	506
9	SPACER	1	STEEL		
10	GASKET RETAINER	1	CHROMOLOY	A.S.T.M. A182, GRADE F6	818
11	YOKE	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	1102
12	YOKE STUDS	2	ALLOY STEEL	A.S.T.M. A193, GRADE B7	106
13	GLAND FLANGE	1	FORGED PLATE	A.S.T.M. A105, GRADE II	175
14	GLAND BOLT NUTS	2	STEEL	A.S.T.M. A194, GRADE 1	182
15	STEM BUSH COLLAR	1	FORGED PLATE	A.S.T.M. A105, GRADE II	175
16	STEM BUSH NUT	1	STEEL	SAE 1020	
17	YOKE BUSHING	1	CAST BRONZE	ASTM B148 GRADE 9B-687	432
18	BEARING WASHER	1	STEEL-EVALIZED	A.S.T.M. A322, GRADE 3	175
19	ANGULAR CONTACT BALL BEARINGS	1		SAE STANDARD	
20	ELBOW FITTING	1	BUTTON-HEAD INDUSTRIAL		
21	CROSSARM	1	CAST STEEL	A.S.T.M. A216, GRADE WCB	102
22	CROSSARM KEY	1	STEEL	A.I.S.I. C1018	102
23	HANDWHEEL (4 SPOKE)	1	MALLEABLE	A.S.T.M. 2852	1000
24	HANDWHEEL (LOCKING)	1	STEEL PLATE	A.S.T.M. A36, GRADE B	118
25	IMPACTOR HANDWHEEL	1	CAST IRON	A.S.T.M. A126, CLASS B	301
26	HEXAGON WASHER	1	STEEL-EVALIZED	A.S.T.M. A194, GRADE 2	175
27	GLAND	2	STEEL	A.S.T.M. A105, GRADE II	171
28	BONNET RETAINER NUTS	6	STEEL	A.S.T.M. A194, GRADE 2H	127
29	BONNET RETAINER RING	1	STEEL PLATE	A.S.T.M. A372, GRADE B	175
30	BONNET RETAINER STUDS	6	ALLOY STEEL	A.S.T.M. A193, GRADE B7	208
31	PACKING RINGS		HIGH TEMPERATURE PACKING		

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

EDWARD GLOBE NON-RETURN VALVE
PRESSURE SEAL BONNET — WELDING ENDS
GENERAL ASSEMBLY

DRAWN [illegible]
CHK'D O. Hotz
APP'D [illegible] DATE: 2-14-56

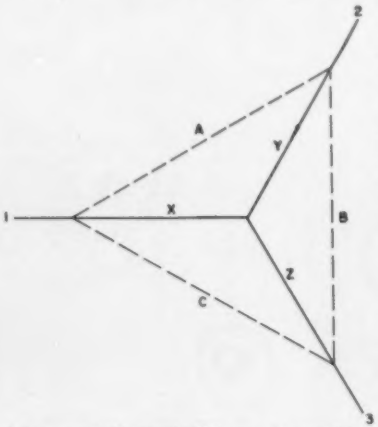
DRAWING NO. AE-3213-6

Measurement of Three-Phase Transformer Resistances

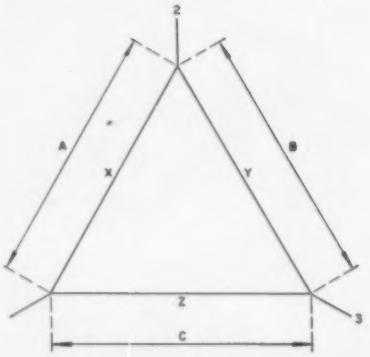
By C. O. VON DANNENBERG

WHEN A maintenance man is confronted with the necessity of finding out which winding of a 3-phase transformer has a fault, he is faced with certain conditions which require care in procedure. There are usually at the outside of the tank only three terminals for each winding and these may be only taps to a completely interconnected network, so that resistance measurements taken between terminals require additional modification to determine the value of each individual winding.

To attempt to get at the actual winding ends at the terminal board inside of the tank would require lowering the oil and make necessary oil handling equipment, storage facilities and pumps. With modern welded covers and nitrogen sealed units all tests must of necessity be made at the terminals on the outside of the tank. If for a star connected wind-



ing a neutral terminal is on the outside of the tank, resistance values between line and neutral can readily be made. The writer recalls one experience where it was necessary to remove over 2,000 gallons of oil at an isolated station, which meant over 50 drums plus pumping and associated facilities which had



to be trucked to the station to complete the work. With the foregoing in mind any method less difficult is a desirable one.

To begin with, the tester must find out and be certain about the interconnections between the windings, whether delta or star, or whatever modification may exist. This information has been given for some years on the diagram nameplate on the outside of the tank, but often one encounters an older unit which may require from the manufacturer the correct information with the serial number as an identifying detail. Figs. 1 and 2 are star and delta connections with identifying indications.

The markings for both Figs. 1 and 2 indicate details as follows: 1, 2 and 3 are the ends of the winding terminals on the outside of the tank, at which the resistance tests are made. A, B and C are the measured resistance values obtained by test, respectively between terminals 1–2, 2–3 and 3–1.

For Fig. 1 each test will include the resistance of two windings in series, X+Y, X+Z and Z+X; so we can write: A=X+Y, B=Y+Z and C=X+Z. As these are simple equations, the values of X, Y and Z can be quickly calculated by equating them in pairs and solving for X, Y and Z accordingly. The final forms become:

$$X = \frac{A-B+C}{2} \qquad Y = \frac{A+B-C}{2}$$

$$Z = \frac{-A+B+C}{2}$$

For Fig. 2 the solution is not so simple, although the approach follows fundamental methods. It is clear that any measurement between terminals includes two parallel circuits made up of one winding in parallel with the other two in series, so we can write:

$$(1)\ \frac{1}{A} = \frac{1}{X} + \frac{1}{Y+Z} \quad (2)\ \frac{1}{13} = \frac{1}{Y} + \frac{1}{X+Z}$$

$$(3)\ \frac{1}{C} = \frac{1}{Z} + \frac{1}{X+Y}$$

And simplifying, these become:

$$(1)\ A = \frac{XY + XZ}{X + Y + Z} \qquad B = \frac{XY + YZ}{X + Y + Z}$$

$$C = \frac{XZ + YZ}{X + Y + Z}$$

This simplification enables us to solve the equations to obtain the values of X, Y and Z, which in their final form are:

$$X = \frac{2(AB+AC+BC) - (A^2+B^2+C^2)}{2(B+C-A)}$$

$$Y = \frac{2(AB+AC+BC) - (A^2+B^2+C^2)}{2(A+C-B)}$$

$$Z = \frac{2(AB+AC+BC) - (A^2+B^2+C^2)}{2(A+B-C)}$$

It is clear that calculations to obtain X, Y and Z are simple, since the numerators are all identical and each denominator is a simple one with only first powers concerned. The equations could have been written without using values A^2B^2 and C^3, and modifying them to first powers, but this modification results in more terms and does not seem worth while since only one set of numerator calculation is required for all three formulas; so that four sets of calculations will give us all the information required. All of the foregoing of course applies to the measurement of any set of three resistors interconnected in a closed ring with a tap at each junction brought out.

fold along this line—outside edges toward you

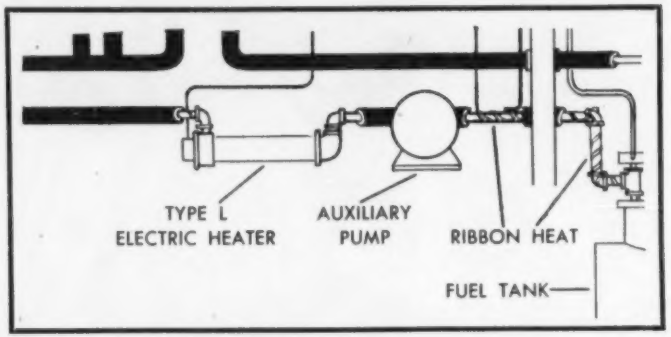
Electric Heating of Heavy Oil

TO CONVEY residual fuel oils from the storage tank to the burner in a fluid state suitable for atomization requires heating of the oil in the piping system.

(1) Ribbon Heat, thermostatically controlled, is a low temperature, protected flexible electric tape which is wrapped helically around the suction piping from tank to oil heater. Electric heat conducted through the pipe maintains the oil temperature at 100 or 120 F.

(2) The Ribbon Heat wound pipe leads to a thermostatically controlled Type L electric heater of the immersion type, which provides the necessary wattage to heat the oil as it is being pumped during operation.

For more information on this system, write to the Handbook Editor, POWER ENGINEERING.



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J. R. P.
Here is an inexpensive, rugged forged steel valve that is quality-controlled to meet the highest standards.
E. B. J.

ROCKWELL BUILT
Edward Valves

Large size knobbed handwheel eases operation.

Deep, full-size stuffing box and Evalpack packing combine to minimize maintenance.

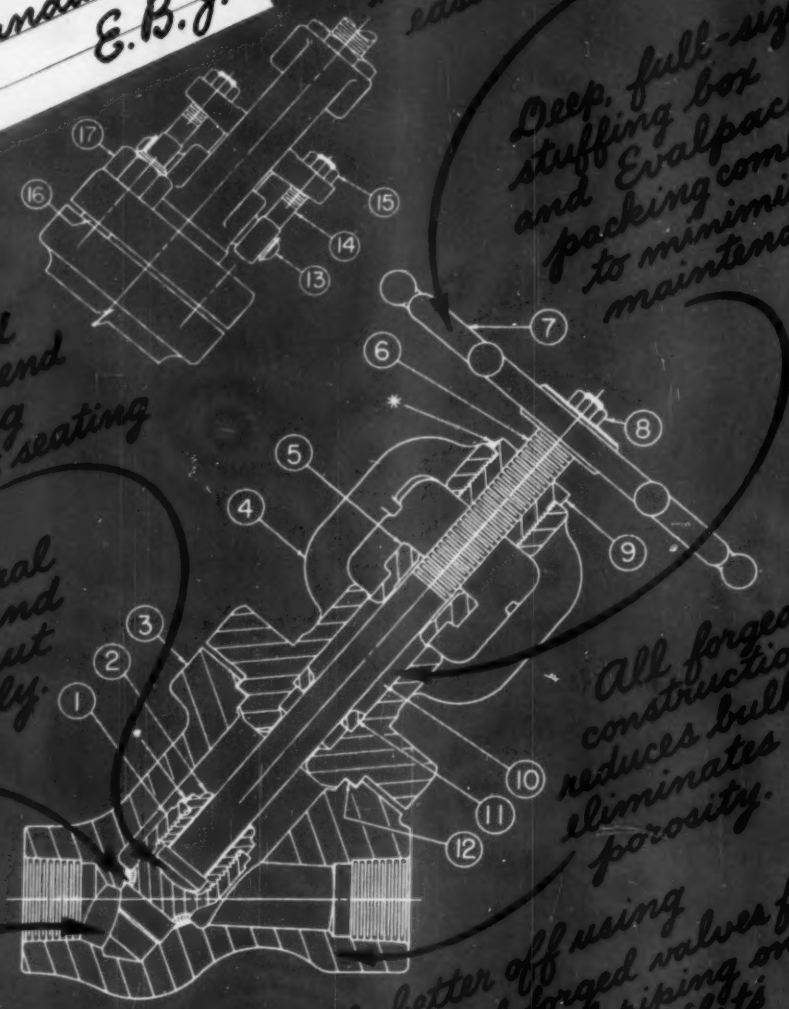
Swivel disk and radiused stem end prevent galling insure perfect seating

Edward integral Stellited seat and Stellited disk cut repairs sharply.

Straight through flow minimizes turbulance and pressure drop.

All forged construction reduces bulk—eliminates porosity.

We'll be better off using Edward forged valves for all small piping on our job. Let's get a bid.



LIST OF MATERIAL
QUANTITIES ARE FOR 1 GLOBE OR 1 ANGLE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	NO. REQ'D	MATERIAL	SPECIFICATIONS	EDWARD MS NO.
1	DISK	1	FORGED ALLOY	A.S.T.M. A182, GRADE F11	227
			STEEL STELLITED		483
2	DISK NUT	1	STEEL	A.I.S.I. G1120	123
3	BODY	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111/483
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227/483
4	BONNET	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227
5	GLAND	1	MALLEABLE IRON	A.S.T.M. A220, GRADE 53004	324
6	STEM	1	EVALLOY	AISI GRADE 416	261
7	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M. A47 GRADE 32510	322
8	STEM NUT	1	STEEL	A.S.T.M. A194 - GRADE 1	124
9	YOKE BUSHING	1	BRONZE	A.S.T.M. B62	412
10	PACKING RINGS		EVALPAK	HIGH TEMPERATURE PACKING	501
11	JUNK RING	1	STEEL-EVALIZED	A.I.S.I. G1120	123
12	BONNET GASKET	1	IRONKOTE		505
13	GLAND BOLT WASHER	2	STEEL		
14	GLAND BOLT	2	FORGED STEEL EVALIZED	A.S.T.M. A105, GRADE II	111
15	GLAND BOLT NUT	2	STEEL-EVALIZED	A.S.T.M. A194 - GRADE O	125
16	TAP END STUD	4	ALLOY STEEL (c)	A.S.T.M. A193	
17	BONNET STUD NUT	4	STEEL (c)	A.S.T.M. A194 -	

EDWARD VALVES, INC.
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FORGED STEEL
GLOBE AND ANGLE VALVES

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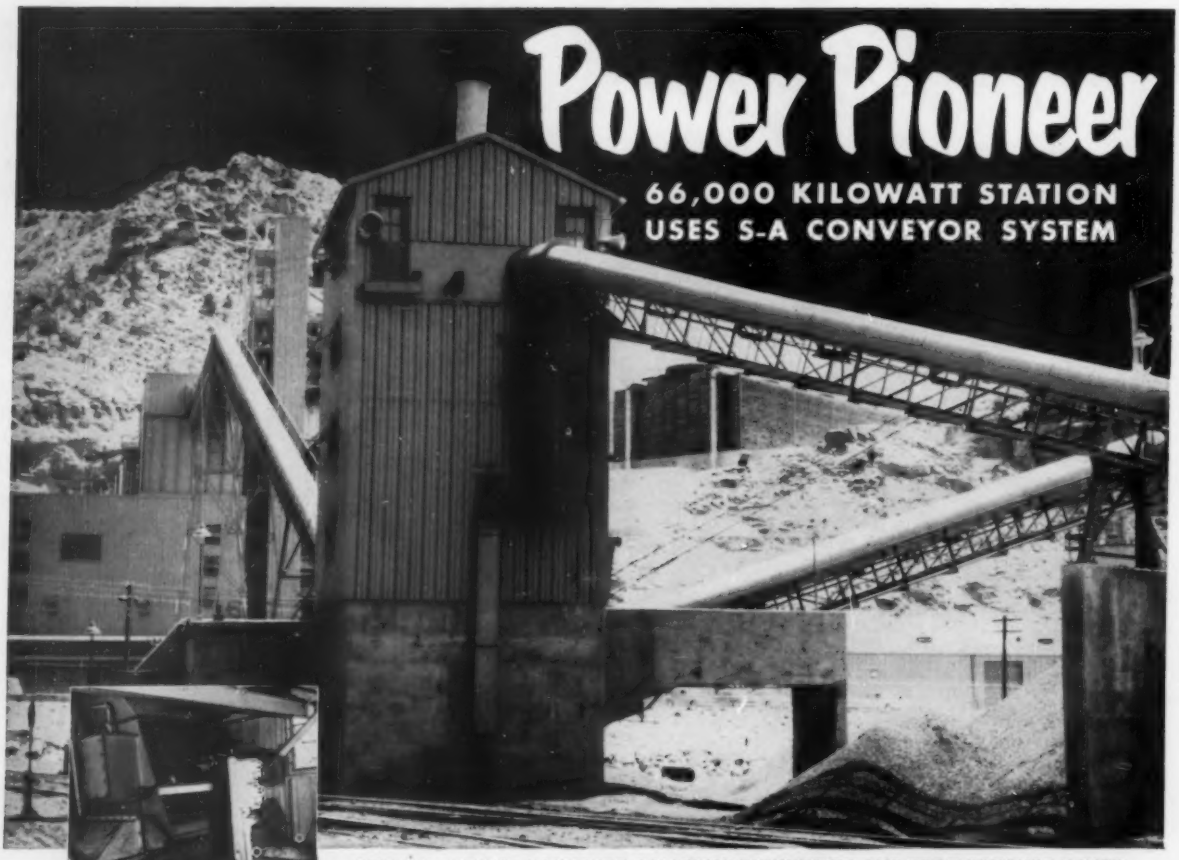
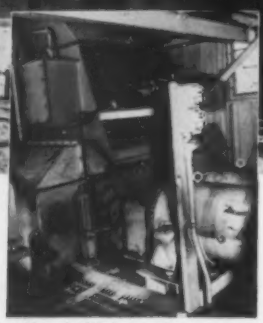
Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

Power Pioneer

66,000 KILOWATT STATION USES S-A CONVEYOR SYSTEM

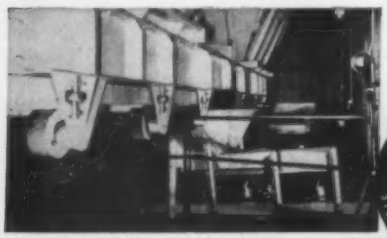


GENERAL VIEW OF CONVEYOR GALLERIES RUNNING TO AND FROM CRUSHER HOUSE



Double rotor knittel crusher processes 200 tons per hr. Coal is broken up by rotating twin sector gangs and dropped through size classifying grate.

Traveling tripper discharges 24 inch conveyor belt at any point into coal bunkers at either side of conveyor. Tripper covers a 55 ft. run.



Coal is discharged from track hoppers by twin S-A reciprocating plate feeders. Coal is moved underground at a rate of 200 tons per hour. Feeders are 40 in. wide by 14 ft. long.

The first steam-electric station to serve advancing power demands in the area, this Utah Power and Light Company plant depends for coal delivery on a conveyor system built and engineered by Stephens-Adamson. Tremendously rich in coal and other mineral deposits, the barren country around Price, Utah is destined to serve one of the nation's future great industrial centers.

As usual, S-A custom designing has been instrumental in effecting initial cost savings. Routine maintenance has been made easy by "in the open" construction.

Coal handling problems get swift and expert treatment by S-A engineers. They are capable of complete plant layout or are available to work in cooperation with your plant engineer.

More than half a century of designing and manufacturing experience is why it will pay you to convey the S-A way. We know how to move bulk materials at lowest possible cost per ton. From our very complete line of manufactured products we can supply the smallest or largest requirements.

STEPHENS-ADAMSON MFG. CO.

86 Ridgeway Ave., Aurora, Ill.—Los Angeles, Calif.—Belleville, Ontario.

ENGINEERING DIVISION
Designers and manufacturers of all types of bulk materials conveying systems.

STANDARD PRODUCTS DIVISION
A complete line of conveyor accessories—centrifugal loaders—car pullers—bin level controls, etc.

SEALMASTER DIVISION
A full line of industrial ball bearing units available in both standard and special housings.

For more data circle 551 on Post Card

Stop Algae Problems *NEW* simple, low-cost way

NEW Allis-Chalmers Algaecide kills all classes of algae and other microscopic organisms in cooling water

If you are troubled by slimes and algae in your cooling tower system, new No. 120 Series Algaecide is the answer. It is the most effective algaecide known. It eliminates such problems as plugged pump strainers, coated heat exchanger tubes, coated slats in cooling towers.

It is easy to introduce into the system by means of a pump, drip feed or manual feed.

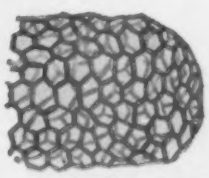
It is safe to handle. Even in concentrated form it is only a mild irritant to skin, eyes and mucous membranes.

Field tests prove that a 5-ppm concentration is toxic to most organisms.

Get complete information on No. 120 Series Algaecide. Call your nearest A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletin 28X8434.

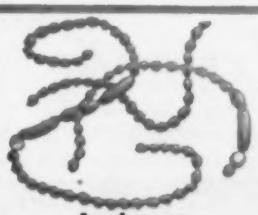
Call on
ALLIS-CHALMERS
for
Water Conditioning

As little as 2 ppm has killed all these algae



Hydrodictyon

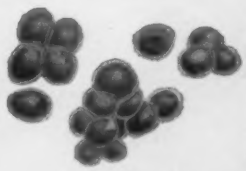
Microcystis



Anabaena

Oocystis

Chlorella



Protococcus

ALLIS-CHALMERS

A-5071

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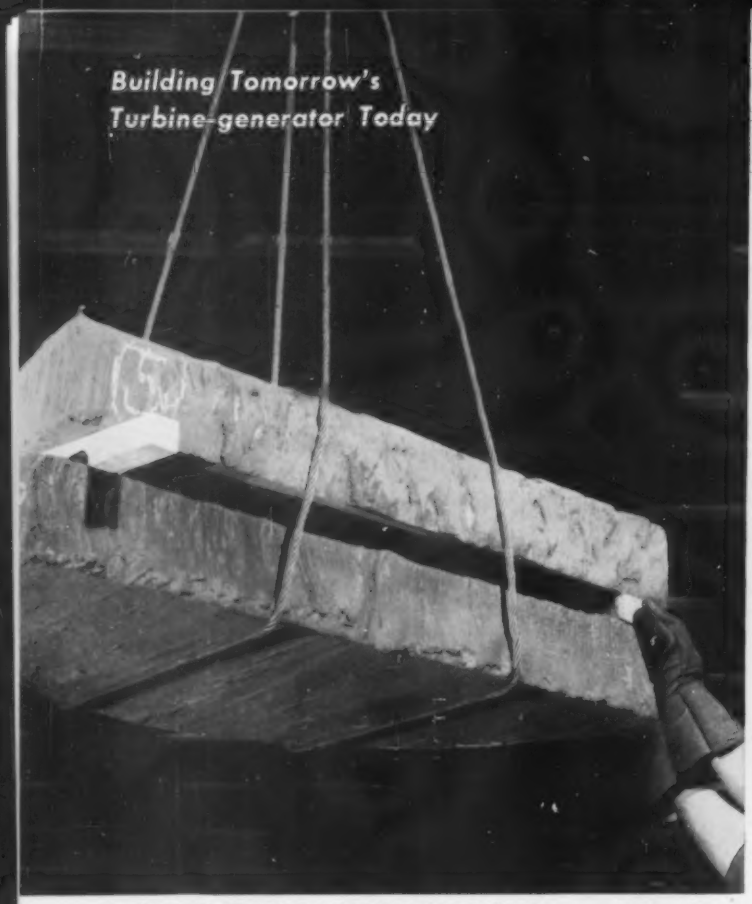
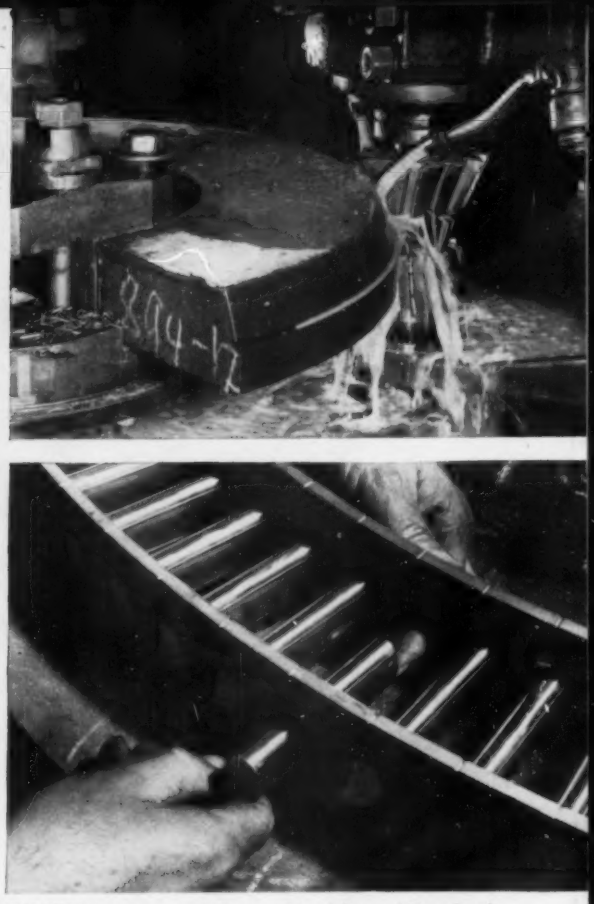


THE HIGH-PRESSURE END DIAPHRAGM WEBS are made from heavy alloy steel plates or castings. Some are ten inches thick and can withstand high pressure drops and maintain close clearances.

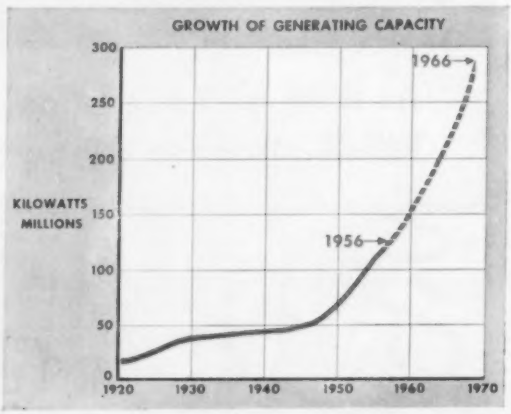


THE WEB is then carefully machined for welding (top). Nozzle partitions are machined from solid chrome-iron alloy and assembled in punched bands (bottom).

How General Electric builds sturdy nozzle-

TO MEET TOMORROW'S EXPANDING LOADS

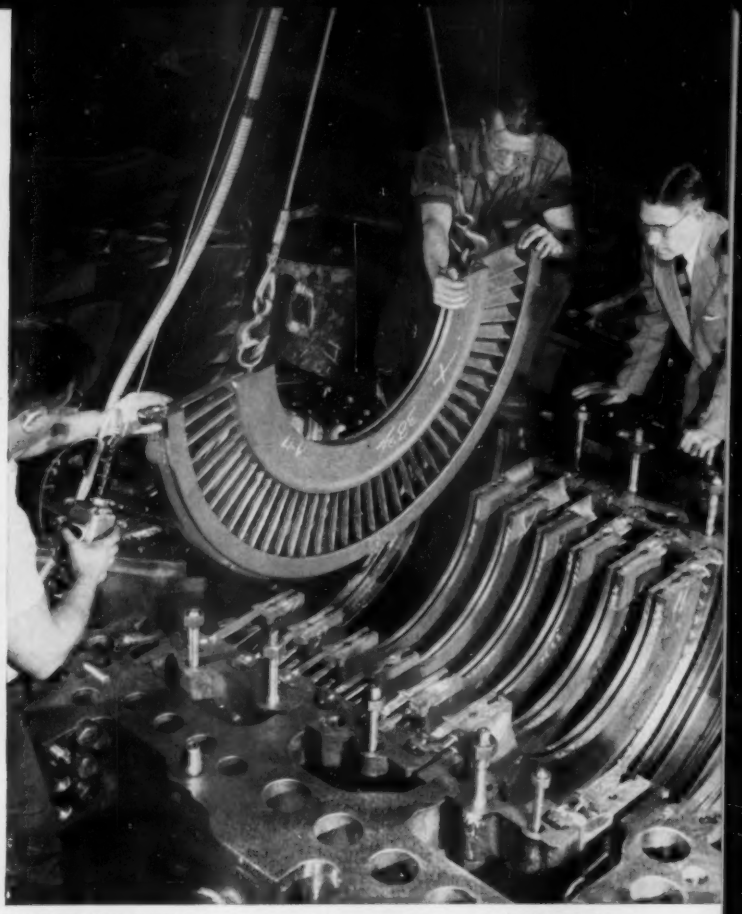
GENERAL ELECTRIC MAINTAINS a continuing program of research on turbine diaphragms. This smoke tunnel provides a visual indication of how steam flow will follow new nozzle designs.



G.E. works with electric utilities and consulting engineers in these vital turbine-generator areas:

- BASIC RESEARCH
- APPLIED RESEARCH
- PRODUCT DEVELOPMENT: **NOZZLE-DIAPHRAGMS**
- TESTING
- MAINTENANCE

THIS NOZZLE assembly is welded to the web and outer ring (top). A finishing operation puts a high polish on the partitions for a smooth steam path (bottom).



DIAPHRAGM HALVES are lowered into the turbine shell. The rotor is then assembled and the upper shell containing the top half of the diaphragm is added to form a series of complete compartments.

diaphragms to reduce turbine maintenance

TOUGH CONSTRUCTION HELPS PROTECT STEAM PATH AGAINST DESTRUCTIVE FOREIGN MATERIALS

Internal damage to the steam path can be a costly and time consuming cause of turbine shutdown. Should large amounts of foreign material enter the steam path whole rows of buckets and partitions might be severely damaged. This could mean a long and costly outage.

TO HELP GUARD against a long outage, General Electric builds turbine nozzle-diaphragms of tough, sturdy construction. And here's how they help. Should foreign materials enter the steam path, these rugged nozzle-diaphragms "compartmentalize" damage to a small area. This greatly simplifies bucket repairs or replacement.

GENERAL ELECTRIC MANUFACTURES these diaphragms from solid castings or plates carefully machined to shape. Nozzle partitions are machined from solid chrome-iron alloy and welded to, or cast integral with, the webs. These partitions must direct the steam flow at the proper angle and velocity to the adjacent buckets.

In this and many other areas of research G.E. is working with electric utilities and consulting engineering firms to design the power makers for tomorrow's load growth. For more information on General Electric turbines write for GER-905, Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, N. Y. 234-40

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- scale, corrosion, or algae growth in your **cooling or condenser water system**
- corrosion or scale in your **hot or cold water tank and lines**
- rust and corrosion in your **brine or sweet water system**
- scaled up **pumps, water jackets, compressors, coils, lines, or equipment**
- sludge and moisture in your **fuel oil supply**
- soot deposits in your **furnace combustion areas**

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Hospital Operations

continued from page 75

released and temperatures and humidities in the room housing the autoclaves were very high. No exhaust fan had been provided to remove the steam vapors and consequently moisture was present on the inside surface of the one exterior wall around the clock. Much of the equipment in use was badly rusted, and trouble was often experienced from grounds and short-circuits in electrical wiring.

Condensate from the traps is now being piped to the condensate return main and an exhaust fan is being installed. These improvements will make the room livable.

Heat Losses Due to Radiation

A tunnel connecting the boiler plant with the buildings contained several thousand lineal feet of steam and hot-water lines, some of which had not been insulated. Much of the piping, which had been installed when the buildings were erected, had been neglected and was in a bad state of repair. Naturally, heat losses from these hot surfaces were considerable.

To make matters worse, this tunnel extended for quite a distance beneath the floor of the main building, and sufficient heat was released to make the affected areas above uncomfortably hot. There was no ventilation in the tunnel.

Many of the smaller rooms and offices were over-heated all winter because none of the risers and condensate return lines which passed through them were insulated. Even with radiators closed off, the radiation from the exposed piping, even in coldest weather was too great to contend with and windows had to be opened; open windows, of course, are no help to the fuel bill.

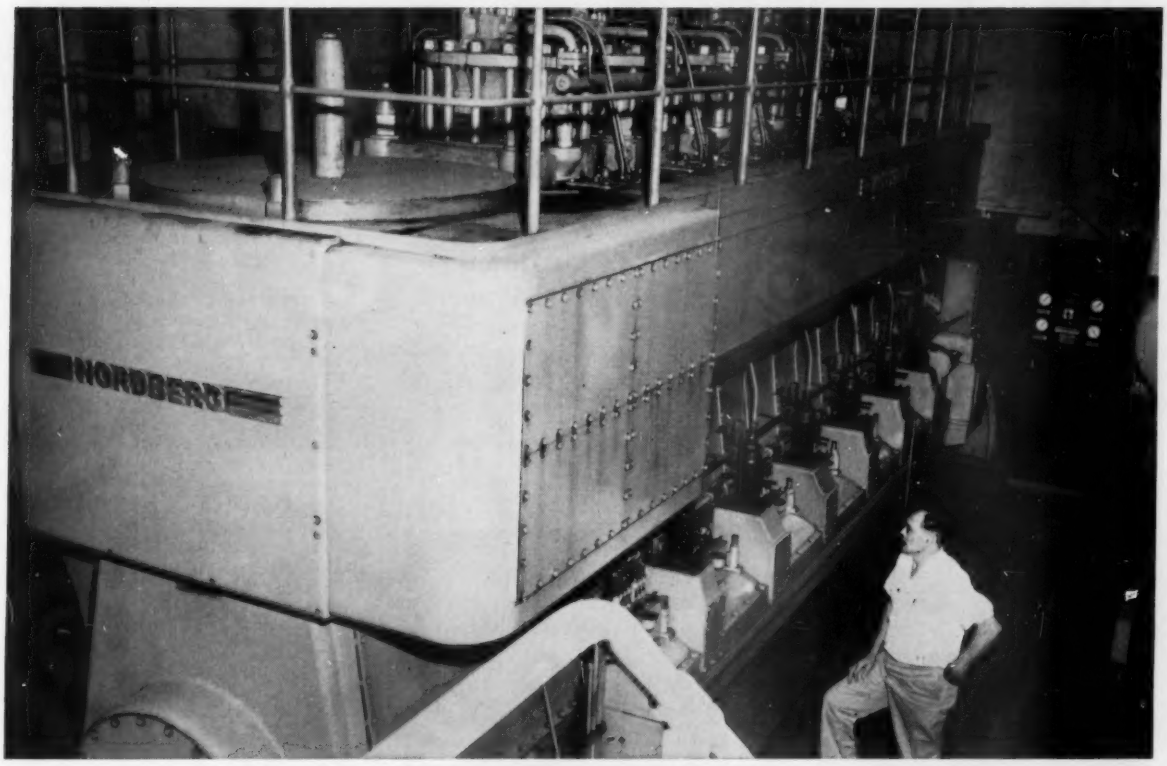
Arrangements are being made to provide insulation wherever it is needed, including the exposed piping in the small rooms and offices.

This story is probably not unusual — doubtless there are many institutions where fuel and power, as well as steam and hot water, are being wasted simply because equipment is not being maintained and is being allowed to deteriorate to the point where it is a constant source of trouble.

WOULD YOU LIKE TEAR SHEETS?

Readers wanting tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue—Editors.

Look to **COOK** for Better Rings!



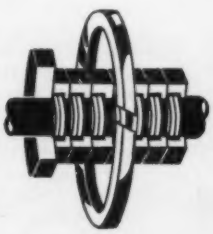
Cook rings save $18 per day on one 2400-hp Diesel engine

WHEN a switch was made to Cook Piston Rings, Key West Electric's No. 12 Diesel showed a saving of $41,670, for 55,542 operating hours — *an average saving of $18 per day!*

There are good, built-into-the-ring reasons why a switch to Cook almost inevitably leads to more efficient performance, more dollar savings. Cook rings are re-turned as a final manufacturing process . . . they're light-tight, conform perfectly to the cylinder wall. This prevents scuffing and power-stealing blow-by. Also, Cook rings are tensioned by a unique, gentle "squeezing" process. Result: constant, uniform tension that *never* wears out.

Get *all* the facts on this $41,670 saving.

Get complete operating data showing exactly how Cook piston rings compared dollar-for-dollar with "X" brand rings. Write for the Key West Electric Story, C. Lee Cook Company, 996 South 8th Street, Louisville 3, Kentucky.



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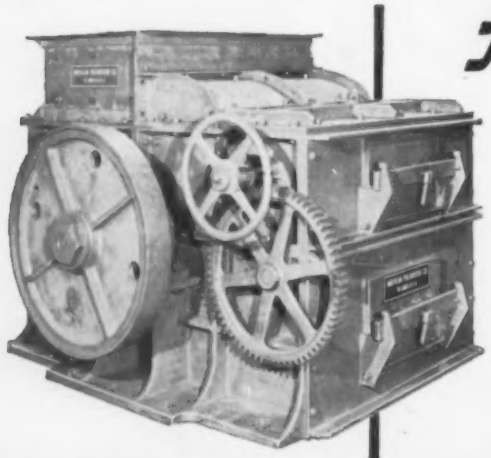
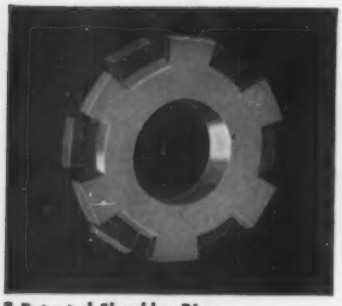
BETTER COAL CRUSHING CONTROL BECAUSE IT'S BUILT BETTER . . .

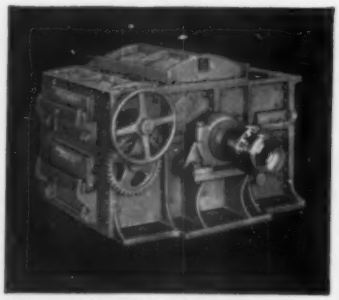
American ROLLING RING COAL CRUSHERS





1 Patented Shredder Ring

American-originated feature that splits coal instead of smashing it—for uniform sizing, minimum fines. Result: Americans run at slow speeds, with savings in power and maintenance. No cams, shear pins, toggles.



2 Heavy-Ribbed Steel Frame

Bearing pedestals are cast integrally with lower side frames. Sectional design for easy dismantling . . . abutting joints accurately machined and bolted together for dust-tight fit.

3 Completely Lined Crushing Chamber

Heavy, renewable liners . . . sectional for easy plate-at-a-time replacement . . . engineered to offer life-time protection to the frame.

4 Complete Accessibility to Adjustment and Parts

All adjustments external—even with crusher in motion. Rotor easily reached by removing top section. Rings readily reversed or replaced. Liners quickly reached, too, for periodical inspection.

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American PULVERIZER COMPANY

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Presque Isle Plant

continued from page 81

owned and operated by the parent company, was formed.

After World War II the expansion and development of the area in which the company operated was very rapid. The increase in energy demands required that generating facilities be doubled by the installation of fuel burning plants in the period 1947–1950. Also, a change was taking place in the method of iron ore mining. Changes in the industry are causing a change in mining operations from the mining of high-grade underground ore bodies to the mining of low-grade surface ore bodies, with subsequent treatment of the low grade ore to increase its iron content and desirability. This change in the method of mining, therefore, creates a high demand for electric energy, causing the iron mining industry to require more power.

The Cleveland-Cliffs Iron Co. desired, therefore, to stop selling energy to other companies and to devote its entire energy production to the operation of its own mining undertakings. It was attempting to cancel some of its resale agreements and, at the same time, was planning to install an additional 11,500-kw steam turbine-generator unit to meet the immediate increases in its load and those of the contracts still in effect.

During 1953, both companies needed additional capacity. But, because of the size of the units and the inability to provide stand-by for larger units, they would have to install power plants of a size expensive in first cost, expensive to operate, and inadequate to meet more than their immediate load requirements.

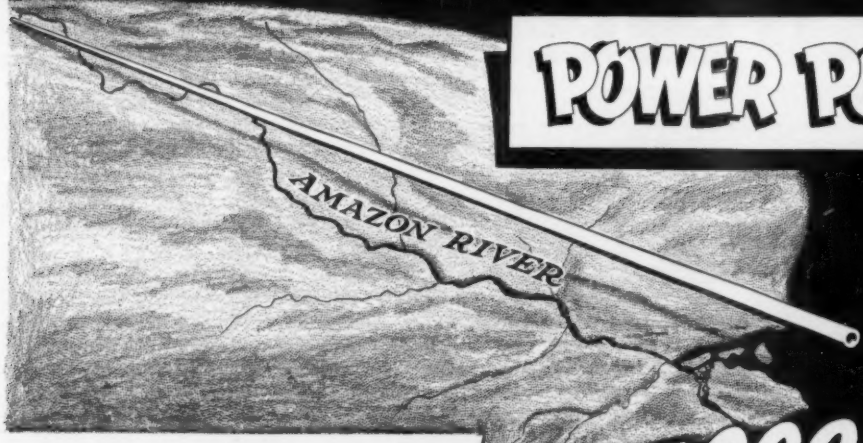
Consolidation Planned

Possible solution, and a step towards the solution of the entire Upper Michigan power dilemma, seemed possible if the two companies could consolidate so that Upper Peninsula Power Co. would take over all of the utility operations of The Cliffs Power & Light Co. and if the two companies could build a power station to be used jointly by them, thus permitting The Cliffs Power & Light Co. to devote its generating facilities entirely to the supplying of energy for the operations of The Cleveland-Cliffs Iron Company.

Early in 1953, the two companies combined on a study of the situation to find if such a solution was economical and practical. The attitude of the two companies was that if the plan as a whole was economically sound, they could then agree on a plan in which the basic savings could be divided between them.

To assist in this study, The Cliffs Power & Light Co. retained Stone & Webster Engineering Corp, and Upper Peninsula Power Co., having a supervisory contract with the Stone

POWER POINTERS



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OF MONEL SEAMLESS TUBING!

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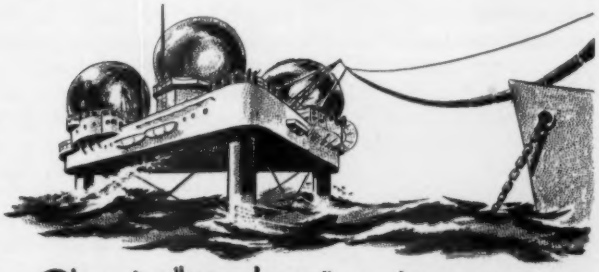
CON EDISON'S NEW ASTORIA STATION DRAWS HIGHLY CORROSIVE, SALTY COOLING WATER FROM THE EAST RIVER. TO PREVENT SHAFT FAILURE FROM CORROSION ON THE FOUR 68,500 GPM PUMPS, CON EDISON ENGINEERS SPECIFIED "K" MONEL* AGE-HARDENABLE NICKEL-COPPER ALLOY SHAFTS.



Sturdy "sea legs" under a Man-Made Island!

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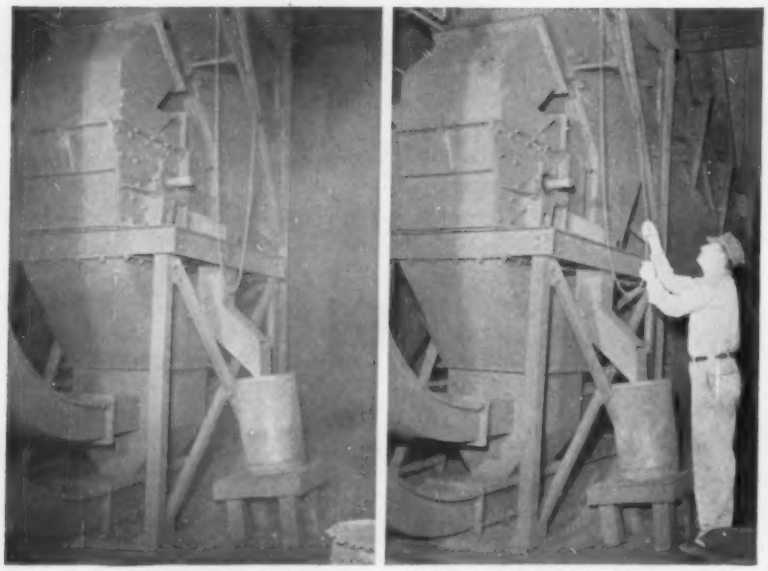

BEFORE **AFTER**

This power plant in Danville, Virginia uses a **Johnson-March engineered liquid dust-control system** to eliminate troublesome coal dust in all stages of their coal handling. From railroad gondolas, where the coal is dumped on a conveyor, to the pulverizer, this plant has done away with the hazard of dust explosion, abrasion and wear and tear on their power plant equipment. Working conditions are greatly improved and maintenance time has been reduced to a minimum.

The before and after photos above are an example of the efficient manner in which the J-M system controls the coal dust in this plant. Even the efficiency of existing mechanical dust collectors can be improved by the addition of a Johnson-March liquid system.

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Presque Isle Plant

continued from page 116

& Webster Service Corp., utilized the services of its engineers in making the study. After full consideration of what the two companies would necessarily do separately or together, it was conclusively proved that consolidation of the two properties would result in a decided reduction in over-all expense.

Single Plant Best

These studies indicated that a 22,000-kw plant to be located in the City of Marquette formed the most economical solution. A basic contract was then worked out, which provided for a new corporation, the Upper Peninsula Generating Co. to be owned 50 per cent by each of the two companies. Upper Peninsula Generating Co. would borrow the necessary capital and issue the stock to obtain the funds for construction of its power plant. After suitable contracts and agreements by the two companies concerning the proportioning of various investment and operating costs, the Public Service Commission of Michigan approved the plan.

Interconnecting transmission lines were constructed, as shown in Fig. 2. On December 16, 1953, actual transfer of properties between The Cliffs Power & Light Co. and the Upper Peninsula Power Co. took place and the two companies began operating on a temporary basis, which was to exist until the first unit of the power plant of the Upper Peninsula Generating Co. was placed in commercial operation.

The Upper Peninsula Generating Co. was incorporated November 23, 1953. As soon as possible, plans for the generating station, Fig. 1, were made by Stone & Webster Engineering Corp. and orders were placed for the basic station equipment. Ground was broken for the new unit on May 15, 1954. Trial operation began in August, 1955, and commercial operation was started a month later.

Beginning of operation of the Presque Isle Plant was, in itself, nothing more than one more steam electric generating station going into operation. However, the manner in which this station came into being and the type of organization to which it belongs constitute an unusual happening in the electric power history of the Upper Peninsula of Michigan. Principles which underlie formation of the Upper Peninsula Generating Co. may well mark an event that will influence the relations between utilities and industries in the future. The fundamental principle underlying Presque Isle Plant offer a very satisfactory solution to a difficult economic problem, which often exists in communities where a large industry and a public utility exist side by side.

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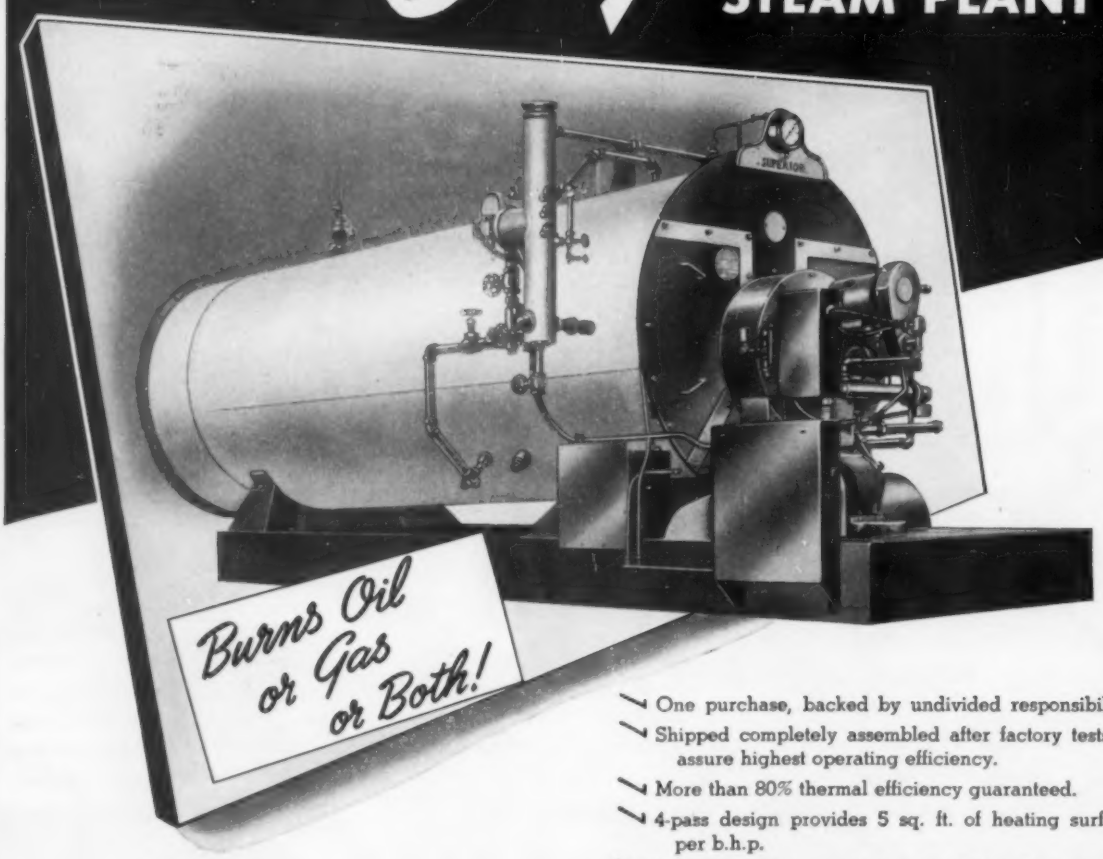

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201 **Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

202 **Nickel Pipe and Tubes** — Bulletin T-17 is a 28-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

203 **Life Extension for Condenser Tubes** — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

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204 **Tube Cleaners** — Catalog 70-A provide 48 pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Thomas C. Wilson, Inc.

FUEL BURNING EQUIPMENT

205 **For Burning Refuse Fuel** — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

206 **Steam Atomizing Oil Burners** — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

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ash from boiler flue gases is discussed in 28-pp Catalog G405. Explains need for collection equipment and gives physical characteristics of fly ash. Describes company's Multiclone equipment as to principle of operation, performance and advantages. Western Precipitation Corp.

208 **Tractor Shovel** — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

209 **Spreader Stoker** — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities to 75,000 lb of steam per hour. Detroit Stoker Co.

211 **Improved Crushers** — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

212 **Why Liquid Diffusion** — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

BOILERS, GENERATORS

213 **Packaged Boilers** — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 40,000 lb per hour. Space requirements are shown in a table along with typical specifications. Also described is control system. Combustion Engineering, Inc.

214 **Compact Generator** — This bulletin describes a packaged water tube generator, company's Type DK, available in units for 8400 to 45,000 lb of steam per hour. Gives features, size and capacity data on these boilers which are designed to require less space than many water tube units. E. Keeler Co.

216 **Steam Generators** — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

217 **Steam Generators** — Type WTP shop-assembled water tube steam generators are detailed in 14-pp Bulletin 5511. Includes technical data, a dimensional drawing with a table of dimensions, a drawing showing tube arrangement and gas passes, and illustrations of basic components. The Titusville Iron Works Co.

AUGUST, 1956
Card void after
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POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the numbers circled below.

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218 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, capacities to from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

219 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

220 Automatic Boilers — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air through static, turbine-like vanes into burner. Boiler Engineering & Supply Co., Inc.

221 Shop-Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

222 Packaged Generators — This 16-pp catalog covers a new series of packaged steam generators in sizes from 10,000 to 46,000 lb of steam per hour. Gives capacities, dimensions, construction features. Instrumentation is discussed. Illustrations include sectional drawings and installation photos. Booklet also provides a selection chart covering firing equipment and controls. Foster Wheeler Corp.

WATER CONDITIONING

224 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or mono-bed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

225 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blow-down adjustment. test control. Dearborn Chemical Co.

226 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please

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Power Engineers and Builders Use
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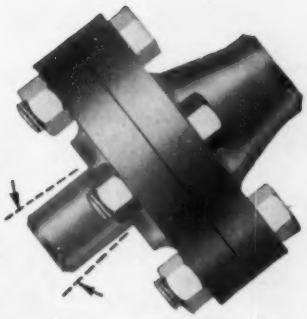

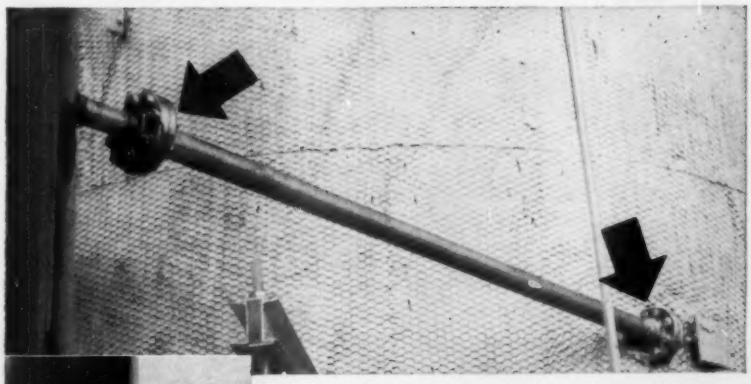

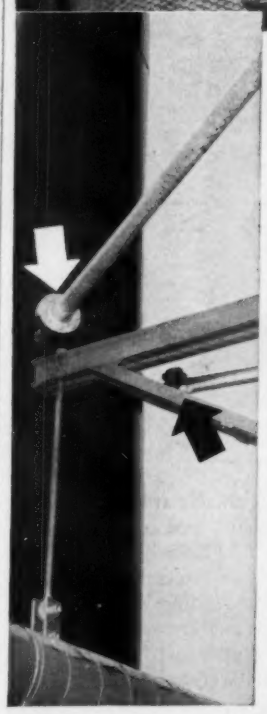

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227 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrite, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness in feedwater. Available to qualified power engineers. W. A. Taylor Co.

228 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical and complete, and points out how it improves steam quality and reduces boiler maintenance costs and downtime. National Aluminate Corp.

229 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coraval process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

230 Carbon Dioxide Measurement — Technical Paper 133, 16-pp, discusses determination of CO_2 in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. W. H. & L. D. Betz.

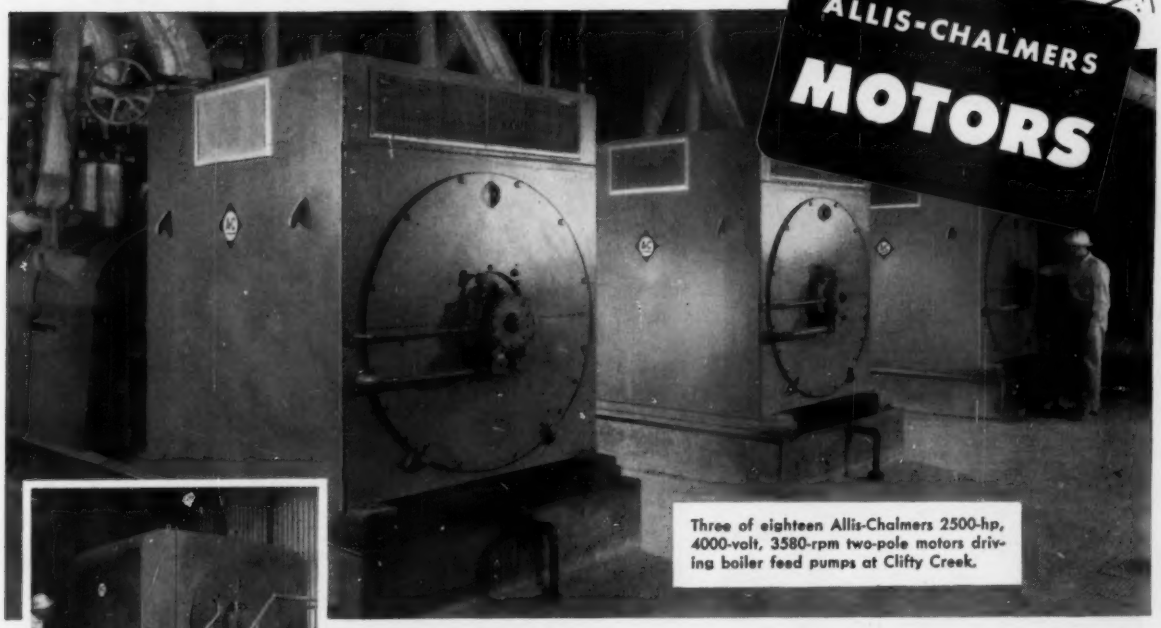
PUMPS, COMPRESSORS

231 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

232 Boiler Feed Pump — Bulletin 08B7899, 16-pp, describes design features and principal advantages of company's barrel type boiler feed pumps. Shows why balanced thrust design gives radial and axial balance for greatest reliability and for smooth operation and longer pump life. Allis-Chalmers Mfg. Co.

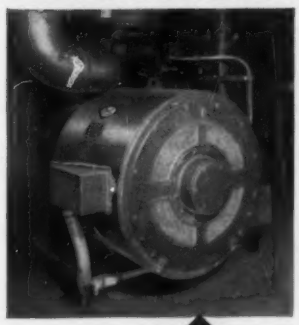
233 Steam Pump Care — Bulletin G-2280, "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting.

Furnishing Major Auxiliary Drive Power at Indiana-Kentucky Electric Corporation's Clifty Creek Plant



Three of eighteen Allis-Chalmers 2500-hp, 4000-volt, 3580-rpm two-pole motors driving boiler feed pumps at Clifty Creek.

Rooftop installation of Allis-Chalmers 1500-hp, 4000-volt, 1185-rpm weather-protected motors. This is one of twelve Allis-Chalmers motors giving dependable service driving forced-draft fans at this modern new plant.



Allis-Chalmers 250-hp flange-mounted motor driving plant air compressor. This unusually economical mounting method for such a large motor can be attributed to Allis-Chalmers experience in motor applications throughout the electric power industry.

A wide variety of Allis-Chalmers motors furnish most of the major auxiliary drive power at Clifty Creek Plant near Madison, Indiana. Allis-Chalmers motors are driving plant air compressors, coal handling equipment, forced-draft fans, boiler feed pumps and many other pumps.

The Allis-Chalmers motors at this Indiana-Kentucky Electric Corporation installation are just a few of the complete line of motors Allis-Chalmers builds for power plant service. Contact the Allis-Chalmers district office in your area, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for complete information. A-4956

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all-silicone-rubber motor insulation. Available only on Allis-Chalmers motors — in many of the larger sizes. Ask your A-C representative for the facts about this revolutionary new insulation system.

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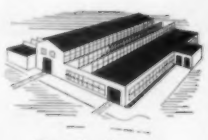
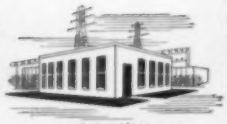
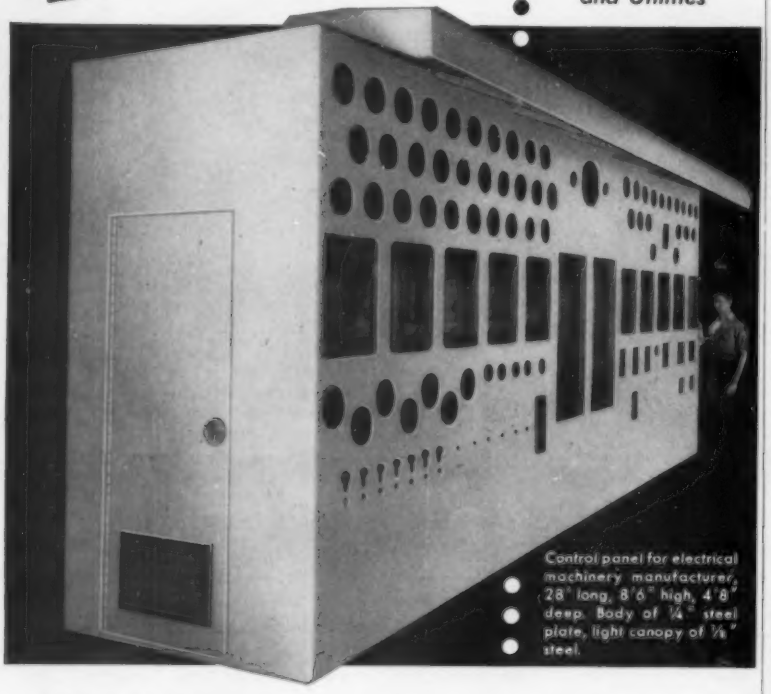


For Industry

Power Plants



and Utilities



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METAL FABRICATION

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Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners, and gaskets. Worthington Corp.

VALVES, TRAPS, PIPING AND ACCESSORIES

234 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

235 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

236 Valve Chart — Form 194, 24 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

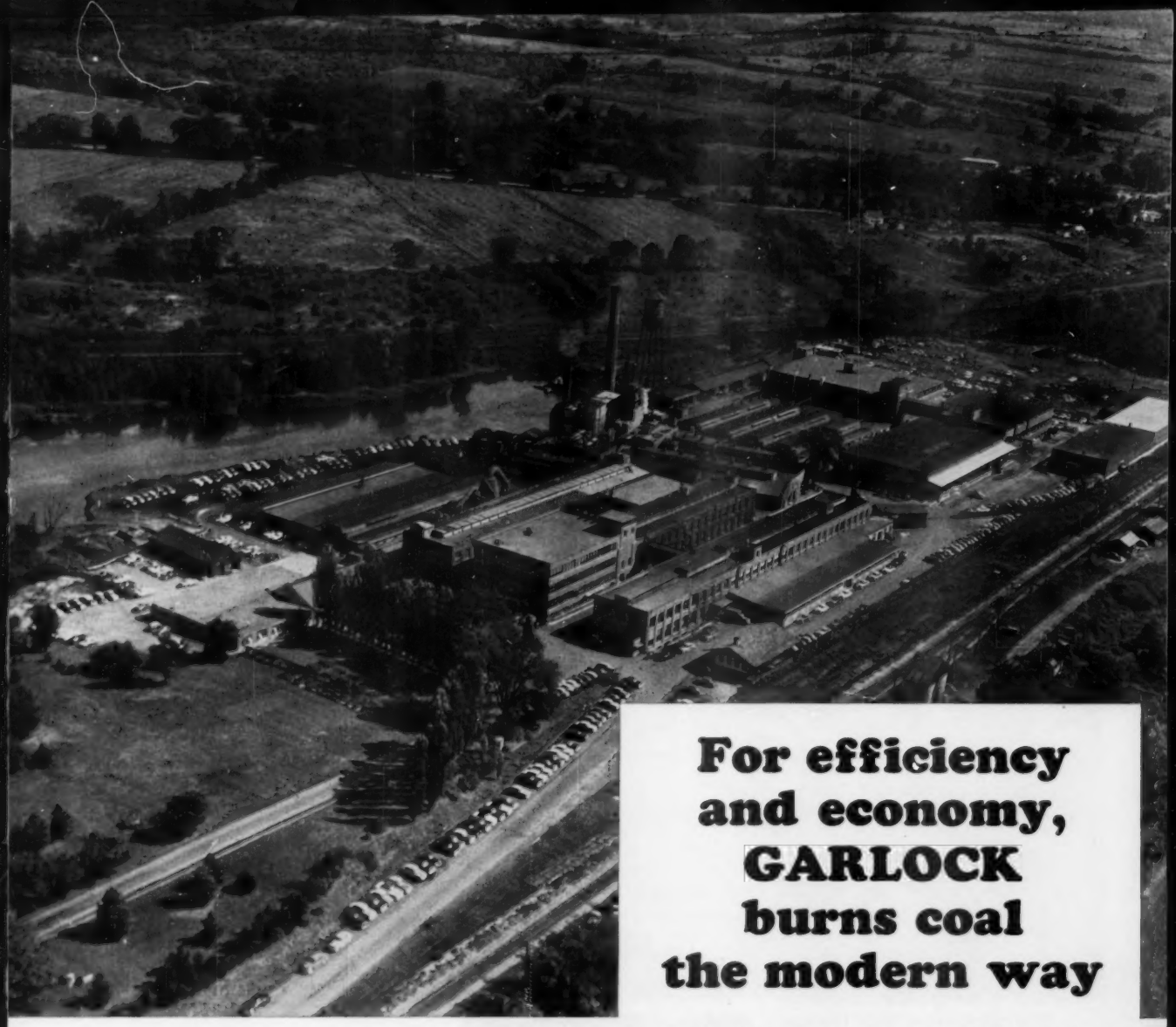
237 General Purpose Valves — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

238 Valve Charts — Now available to power engineers are three well-organized wall charts on valve types, selection and protection. "How to know valves" covers four main types of valves from the standpoints of their appearance, inside construction, service intended, operation and use. "How to select valves" discusses five major factors involved in the choice of a valve — fluid, temperature, pressure, size and function. "How to protect valves" — written in "do and don't" style covers 11 important points in valve installation, operation and maintenance. R-P & C Valve Div., American Chain & Cable Co., Inc.

239 Regulating Valves — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

240 Pump Valves — Key features of company's line of pump valves are outlined in 6-pp Bulletin V-112. Includes cutaway view showing design features, standard materials table, and a table of valve sizes. Sims Pump Valve Co., Inc.

241 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed. Crane Co.



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The Garlock Packing Co., Palmyra, N.Y., had a problem common to many growing firms. Production requirements threatened to outpace its power system. Steam capacity and electrical distribution were inadequate; heat balance was poor; equipment was obsolete. Any minor repair or inspection meant curtailed production. So Garlock called in Consultant L. J. Sforzini to study the situation and make recommendations.

The answer was *modernization* and today Garlock burns coal the modern way. A new 100,000 lb.-per-hr. spreader-stoker fired boiler, using older units as standbys, delivers steam for all needs with enough surplus capacity to handle a load growth. Cinder reinjection has improved stoker-firing efficiency. Pneumatic ash handling facilitates overall operation. With these and other changes, Garlock's power plant now operates at peak efficiency and economy.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

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Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

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Specify economy Costing less than circuit breakers and with interrupting capacity not found in air break disconnects, 3E Air Interrupters are ideal for . . . interrupting magnetizing charging current of transformers . . . interrupting charging current of lines and busses . . . interrupting exciting current of feeder regulators . . . interrupting load currents to rated capacity . . . sectionalizing feeders and distribution circuits.

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Howard Noble, 3E Sales Promotion Mgr., demonstrates Air Interrupters in a complete cubicle installation.

3E Air Interrupter Switches are made in ratings up to 15 K.V.

Write for Bulletin 152

ELECTRICAL ENGINEERS EQUIPMENT CO. Melrose Park, Illinois

Representatives in principal cities—in Canada by Power-Lite Devices, Ltd.

For more data circle 564 on Post Card

242 Industrial Valves — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines, Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

243 Boiler Blow-Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

244 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

246 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

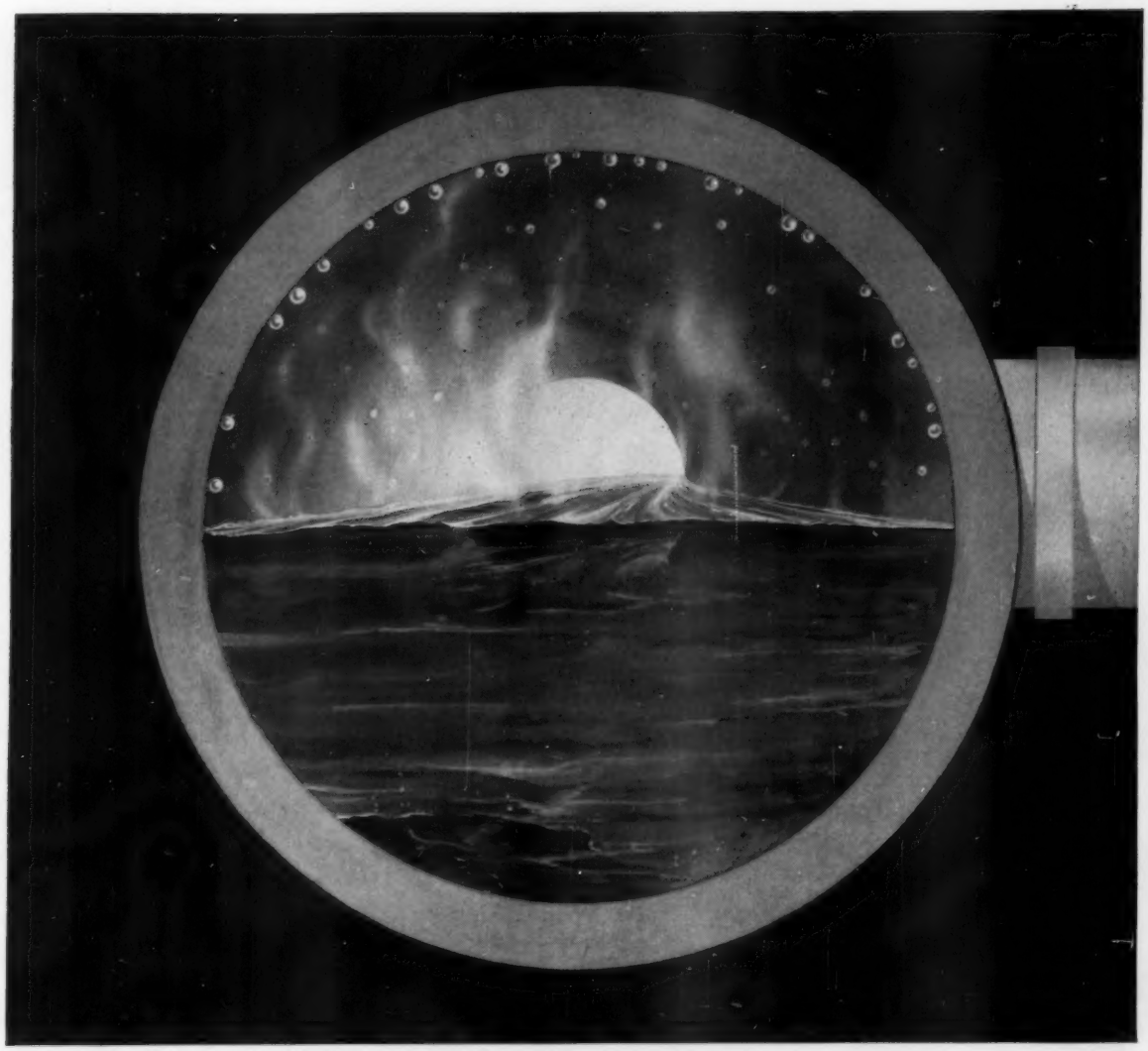
247 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

248 Expansion Joint Guide — Catalog 153, 24-pp, a complete design guide for application and selection of expansion joints, is filled with engineering data necessary to solution of pipeline expansion problems. Includes a discussion of types of expansion joints available and types of pipeline motion solved by expansion joints. Includes a schematic piping layout illustrating expansion joint applications and principles, as well as full specifications. Flexonics Corp.

249 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

MECHANICAL POWER TRANSMISSION

250 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multi-color tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horse-



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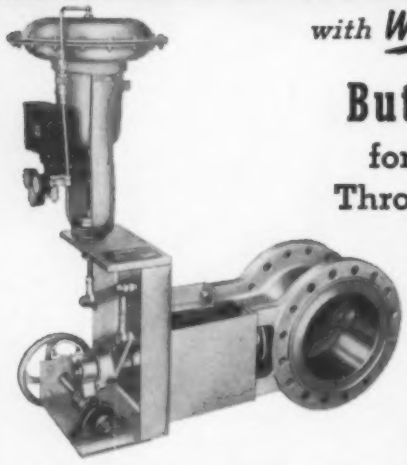

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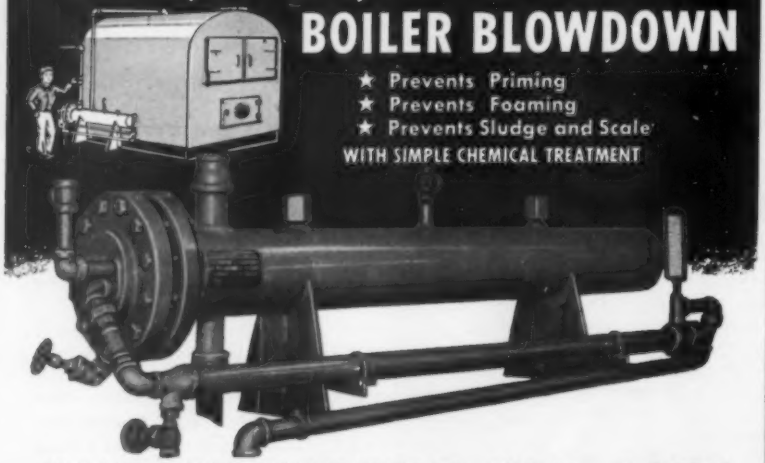

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power rating tables for A, B, C, D, and E section belts, a speed range table showing variation in rpm when using two Vari-Pitch sheaves in combination. Allis-Chalmers Mfg. Co.

251 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation, etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

252 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

REFRACTORIES, INSULATIONS

254 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

255 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for efficient control of temperatures from — 400 F to 3000 F. Johns-Manville.

ELECTRICAL EQUIPMENT

257 Plug-In Busway — Twenty-pp Bulletin GEA-6470 describes the factory-assembled Flex-A-Power plug-in busway system permitting direct connection to bus bars for feeding lighting and power loads in industrial plants and public buildings. Describes in detail the construction and application of this busway system. Also lists ratings, weights, dimensions, installation data and guide form specifications. General Electric Co.

258 Testing Instruments — Bulletin 19-56, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corena test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

260 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and

cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

INSTRUMENTS AND CONTROLS

262 Metering and Control Equipment — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and engineering services. It is written for engineers in power plants, public utilities and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

263 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

264 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

265 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

266 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

267 Solenoid Pilots — Several types of solenoid pilots for use with company's regulating valves are described in Form 1010. Lists reasons for economies in on-off control, describes applications, and gives type of pilot, material of construction, maximum pressure and maximum temperature for two- and three-way pilots in steam, air, gas and liquid service. Schematic diagrams of typical applications are given. Spence Engineering Co., Inc.

(More Catalogs on page 133)

BIRD-ARCHER Amine Treatment
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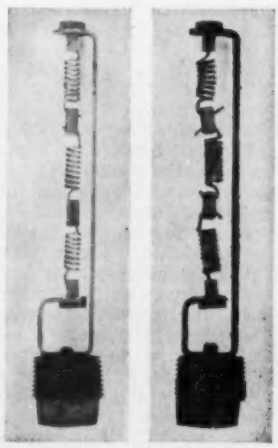
Return line corrosion is one of the most critical problems in maintaining economical, efficient power plant operation.

Bird-Archer Amine Treatment is an easy, effective and economical way to eliminate corrosion troubles. Amines raise the pH value of the return condensate to the point whereby the corrosion potential is negative. In addition, amines provide a surface protection for the metal itself which further inhibits corrosion. In scores of plants, Bird-Archer Amine Treatment is paying a profit on its cost through savings in piping replacement and maintenance work.

To demonstrate what corrosion can do in steam and condensate return lines, we show here "before" and "after" unretouched photographs of NDHA Corrosion Testers. This is a test* developed by the American Society for Testing Materials in cooperation with the National District Heating Association. Bird-Archer supplies and analyzes these testers. Photo at left shows a Tester before installation. Photo at right shows a Tester after it had been installed for 60 days in the return line. (*Standard Method of Corrosivity Test of Industrial Water, NDHA Method, ASTM Designation 935-49.)



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Stuffing Box Packing

continued from page 83

bled-off to the heater at the suction of the primary pump.

Let us further assume that when the pump is new, this leakage amounts to 12,000 lb/hr per box or 24,000 lb/hr total. The primary pump must therefore be designed to handle a gross capacity of 624,000 lb/hr.

The net effect of these pressure reducing labyrinths is to increase the whp of the primary pump by 14.7 hp. Assuming a pump efficiency of 76 per cent, this corresponds to 19.3 bhp. By the time the clearances have doubled and the leakage through them has doubled accordingly, the excess in power consumption introduced by the need for a pressure breakdown device will have increased to almost 40 bhp.

There are two other problems to consider in the application of the single pressure reducing breakdown illustrated in Fig. 1. The first arises from the need of disposing of the bleed-off leakage which will be at a high temperature and which — especially at low pump flows — represents a very appreciable proportion of the total feedwater flow. In the case of closed feedwater cycles, this leakage must be returned either to a low pressure heater where it may disrupt the heat balance or to the condenser itself, where the entire heat in this leakage is lost.

The second problem is due to the possible flashing of the leakage in the relief chamber immediately preceding the stuffing box proper. Consider, for instance, the case of the installation illustrated on Fig. 3. At full load, the feedwater temperature entering the pressure breakdowns is 400 F. Assuming that the losses in the return piping to the heater are kept to the modest figure on 5 psi, the pressure in the relief chamber will be 30 psig (made up of the heater pressure, the static head up to the heater and the friction losses in the return piping).

The degradation of pressure through the breakdowns from 470 psig down to 30 psig will raise the temperature of the leak-off by approximately 1.5 F. to 401.5 F. But the vapor pressure of 401.5 F. water is 238 psig, considerably in excess of the 30 psig in the relief chamber and flashing will occur within the pressure breakdown itself.

It is true that certain pump designs exist with sufficient rigidity, absence of vibration and freedom from internal contact at the running joints which can stand the flashing that takes place under these circumstances. Most power plant operators, however, tend to shy away from such a condition and pump designs also exist for which this condition would be intolerable.

The first solution which presents itself is to raise the back pressure at the relief chamber to some value in excess of 238 psig by throttling in the return line. In such a manner, any flashing will take place externally to the pressure reducing breakdowns and never endanger the pump operation.

On the other hand, this solution suffers from the fact that it reduces the effectiveness of the pressure reducing device, in that the pressure on the stuffing boxes is reduced from 470 psig to some 250 psig instead of to the 30 psig which would prevail were we not to raise the back pressure.

In order to reap the benefits of a complete pressure breakdown while still avoiding the dangers which may arise from flashing in the breakdown itself, a double breakdown with intermediate injection has been used in some installations.

Double Pressure Breakdowns with Injection: Whether the main feed pump receives its suction from the condensate pump in a closed cycle or from a booster pump in an open cycle, as in Fig. 3, the discharge pressure of the pump immediately preceding the feed pump exceeds the suction pressure of the main feed pump by the amount of the frictional losses between the two. At the same time, the feedwater temperature at the discharge of this first pump is considerably lower than at the suction of the main feed pump. Some of this feedwater can therefore be made to by-pass the closed stage heaters and can be injected into the central portion of a double breakdown, as illustrated in Fig. 2 at A, B, C.

If such a construction is incorporated in the feed pump serving the system illustrated on Fig. 3, the injection pressure would be 525 psig less the slight frictional loss in the injection piping, or say 520 psig. A small portion of the injection feedwater should proceed internally into the main feed pump at D since the pressure there would be approximately 470 psig, since the pressure in the balancing device F is practically suction pressure.

Thus the pressure differential across the internal portion of the double breakdown i.e. between C and D, would be only 50 psi. The remainder would proceed externally from C to E, and be returned to the direct contact heater exactly as when single pressure breakdowns are used. The pressure drop across the external portion of the pressure breakdown AC, C to E, would be 520 psig less the 30 psig back pressure or 490 psi.

The main advantage of this construction is that it reduces the temperature of the external leakoff to that of the feedwater handled by the condensate or primary pump, as the case may be and avoids flashing. The disadvantage is that it further complicates the pump construction, introduces the need for additional piping and, of course, retains the same economic disadvantages as the single pressure breakdown.

Fairless Works

continued from page 79

from Fairless Works have been treated except blast furnace flue dust wastes. Gas from the blast furnace carries with it about ¼ of a ton of dust for every ton of iron produced. Dust is removed from the gas by dry dustcatchers, wet washers and wet-type electrostatic precipitators. Thus, it is not only desirable to recover the dust from a stream pollution standpoint, but is highly desirable from the standpoint of economical operation of the plant.

A separate treatment plant was installed at the blast furnace site to eliminate long sewers and extensive handling. This unit (Figs. 1 and 6) provides essentially three stages of treatment; primary settling, mechanical flocculation with lime, final clarifying.

Coke Plant Wastes

With respect to coke plant wastes, there is no problem involved because these wastes are segregated in a separate circulatory system which is closed within itself. These wastes are used for coke quenching and, since they are included in a separate system, they do not enter the river.

Sanitary Sewage Treatment

Sanitary sewage at Fairless Works comprises flow from toilets, wash rooms and showers. Since the plant is served by a separate system of sanitary sewers, little or no waste other than sanitary flow enter the treatment plant. Requirements for effluents discharged into the Delaware River are that practically all suspended solids and 85 per cent of biochemical oxygen demand be removed from the sewage. Thus, both primary and secondary treatment is required. Past experience with other industrial installations indicated that certain problems must be met. These included the possibility of low or zero flows during holiday or shutdown periods, wide and sudden variations of both flow and quality of the sewage, and the essentially weak characteristics of the raw sewage, about one-third the strength of normal domestic sewage.

An interesting feature of this plant is the trickling filters (Fig. 5). These are each 75 ft in diameter with 7 ft of stone and are completely enclosed by 4-in concrete domes, thus assuring uniform operating temperatures, confinement of odors and flies, and elimination of difficulties due to heavy rainfall, snow, and ice.

Sludge is discharged and dried about eight times a year. There are four glass enclosed drying beds, each with 600 square feet of area (Fig. 3). The digested sludge flows by gravity to the beds and filtrate will flow back to the pumping station wet-well for recirculation. The dried sludge is shoveled into traveling mono-rail buckets and trucked out.

268 **Easy Reading Gage** — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

269 **D-C Amplifier** — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier, and describes some applications. Hagan Corp.

LUBRICATION

270 **Turbine Lubrication** — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations. DeLaval Separator Co.

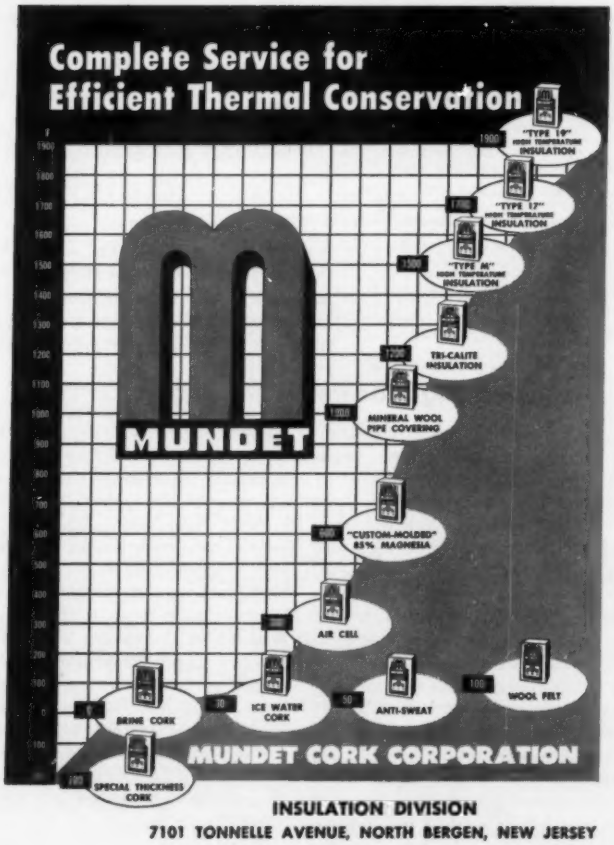
271 **Bearing Lubrication** — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

273 **Versatile Industrial Oil** — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

OTHER EQUIPMENT

274 **Preheating Combustion Air** — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

(More catalogs on page 135)



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Corrosion in Condensate

continued from page 91

resulting from elimination of corrosion in condensate lines have been estimated at $10.00 per day.

Another paper mill, where octadecylamine acetate was applied to feedwater, also experienced economizer deposits which were composites of iron oxides, amine, and other water conditioning chemicals. Deposition was heaviest on the inlet side of the economizer, and decreased progressively through the unit. (Average temperatures were 200 F at inlet, 260 F at discharge.) Although turbines and condensate system were fully protected, free amine traces liberated in feedwater by reaction with other chemicals apparently contributed to the accumulation of sticky deposits on low-temperature economizer surfaces. Feed to steam headers corrected the trouble.

These two examples well illustrate the difficulties occasionally encountered when filming amines are fed ahead of the boiler. In such instances, filming amines fed direct to the boiler or to steam headers will give satisfactory condensate corrosion inhibition.

4. *Building Heating Problems:* In a government hospital, Filmeen treatment reduced corrosion rates in a condensate system by 87 per cent within five months. In three other buildings, corrosion rates in heating system returns were reduced from 51, 18 and 37 mils per year to 1.2, 1.2 and 2.6 mpy, respectively.

At a midwest university prior to starting Filmeen treatment, corrosion attack due to dissolved oxygen leakage in branch returns was severe. Dissolved iron in condensate precipitated and formed deposits in main return lines, down-stream from branch line discharge points. Differential aeration corrosion beneath these oxide deposits caused rapid penetration of return lines. Application of Filmeen treatment removed accumulated deposits and arrested corrosion.

5. *Lumber Mill Problems:* A group of lumber mills located in the Pacific Northwest experienced severe corrosion of dry kiln condensate lines. In one instance, a new dry kiln in operation only three months required complete replacement of piping assemblies. Other units experienced corrosion failures of return lines in 15 to 30 days. Application of Filmeen at dosages of 1.5 to 3 ppm arrested corrosion and sharply reduced maintenance costs.

In a California mill, the replacement of corroded pipe in dry kilns had become routine Sunday practice. After starting Filmeen treatment, corrosion failures were stopped. It was possible to eliminate overtime and Sunday maintenance operations, thereby saving $5,000.00 per year.

In plants which burn sawdust or waste fuels of varying heat values, and which are not equipped with meters to determine steam production and feedwater rates, it is difficult to estimate and control treatment dosages. For such installations, small chemical pumps driven by reciprocating boiler feed pumps can provide accurate chemical feed in proportion to steam output.

6. *Improvement of Heat Transfer:* A filming amine treatment was applied to a rag felt machine. An Appleton paper machine is used for drying the rag felt with steam entering the rolls at 50 psi. There are 92 rolls in the machine, each 36 inches in diameter. The machine is in sections of reducing pressure stages (12 to 16 rolls per section) with steam separators and pressure reducers between stages. Prior to the use of the filming amine the skin temperature of the roller was 275 F to 280 F. It was very exceptional to reach a temperature of 290 F. With the use of the filming amine treatment, the temperature was increased to 300 F, representing an increase of 20F to 25 F. This increase in heat transfer made possible an increase in the speed of machine of from 5 to 10 feet per minute, resulting in a production increase of about 5 per cent.

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3. Straub, F. G., "Comparison of the Action of Ammonia, Amines, and Hydrazine in Reducing Metal Pick-up in the Condensate and Feedwater Systems of Closed Cycle Steam Power Plants", Proc. 14th Ann. Water Conf., Engrs. Soc. of W. Pa., 90-93 (1953).
4. Denman, W. L., "Method of Treating Waters, Including Boiler Waters, and Composition Therefor", U. S. Patent No. 2,400,543 issued May 21, 1946.
5. Denman, W. L., "Method of Treating Waters, Including Boiler Waters, and Composition, Therefor", U. S. Patent No. Re. 23614 issued January 13, 1953.
6. Wilkes, J. F., Denman, W. L., and Obrecht, M. F., "Filming Amines — Use and Misuse in Power Plant Water-Steam Cycles", Proc. 17th Ann. American Power Conf., 527-535 (1955).
7. Collins, L. F. and Henderson, E. L., "Corrosion in Steam Heating Systems", *Heating, Piping and Air Conditioning*, 539-542 (September, 1939).

Engineering Books

Introduction to Solid State Physics, by Charles Kittel; 1st edition, 396 pages, 6¼ x 9¼ ins.; cloth binding. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1953. Price $7.00.

This book on solid state physics is a very welcome edition to modern scientific literature. During the past half century, innumerable books have been published on the physics of gases and liquids, but little has been written about the solid state. The reason for this, of course, is that the gaseous or liquid state of matter has been relatively simple to explore. It is simpler to deal with atoms as individual entities than in the aggregate.

As the author points out, solid state physics is a very wide field and it includes many branches. It is concerned with the physical properties of solids, particularly the special properties exhibited by atoms and molecules because of their association in the solid phase. The existence of powerful theoretical methods and concepts, applicable to a wide range of problems, has been an important unifying influence in the field. It is quite natural, therefore, that in an introductory textbook the author should emphasize theoretical models of solids rather than the details of experimental techniques or the results of measurements on complicated systems which may have great industrial importance. The author frankly favors those areas which may be discussed in terms of simple concrete and well-developed models.

This book is not intended as a general reference book. Several active and important branches of solid state physics have not been mentioned at all. Among the topics omitted are internal friction, photographic theory, thermoelectric effects, phase diagrams, fracture, creep, grain boundaries, melting phenomena, field emission, oxide cathodes, surface physics, radiation damage, crystal counters, piezoelectricity, liquid and solid helium, plastics and molecular crystals.

The increasing interest in the characteristics of semi-conductors and the effects of radiation on material, should stimulate interest in this new book. The author is professor of physics at the University of California at Berkeley.

★ ★ ★

Introduction to Nuclear Engineering by Richard Stephenson. First Edition, 387 pages, 6 by 9 in.; cloth. Published by McGraw-Hill Book Co., Inc., New York, N. Y., 1954. Price $8.00.

This is a book for the engineer who will be making practical use of nuclear energy. Based on the work of engineers and scientists already in the field, it gives authoritative information on nuclear fission, the nuclear chain reaction, reactor theory, radiation shielding, reactor materials and control, separation of stable isotopes, chemical processing of radioactive materials, remote handling equipment, and special engineering problems.

Much of this book comes from personal discussions with engineers and scientists now working with nuclear energy. It includes a great many examples and problems, and references to declassified reports that will give more detailed information.

After a brief review of elementary nuclear physics, this book discusses the basic data concerning nuclear fission and shows how these data are used in the production of a nuclear chain reaction. It provides an understanding of the engineering problems encountered in the design of reactors by taking a look at the various reactors which have been constructed. The unique requirements for materials used in the construction of reactors are also taken up.

This is a good practical book for the engineer who wants to get into this tremendously fertile field.

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275 **Product Guide** — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

276 **Steam Condensers** — Some recent additions to this company's power plant condenser installations are pictured and described briefly in this 24-pp booklet. Also included are an engineering section on condenser design factors, and sections devoted to air removal equipment, to steam condenser specialties, and to maintenance services available. Condenser Service & Engineering Co., Inc.

277 **Steam Turbines** — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

278 **Turbine Speed Control** — Thirty-pp wire-bound Bulletin H-21 is titled, "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify the operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

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. . . for a Utility in Central America, consisting of a new high pressure 30,000 KW Steam Power Plant, an existing 10,000 KW Diesel Power Plant, 170 miles Transmission Lines, and Distribution Systems in one large city and 15 outlying towns. Minimum 5 years' experience. Good working conditions with initial contract for 2 years — with option for renewal. Working knowledge of Spanish desirable, but not necessary. All applications will be acknowledged. In reply, state age, experience, education, salary expected, and availability date. Box 1713, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

STEAM AND POWER ENGINEER

A permanent position for a graduate engineer with experience in steam-electric power plant design is available in a large diversified pulp and paper manufacturing plant in the Upper Midwest. Our employees know of this opening. Reply giving personal, educational, and work history together with salary thinking. Your reply will be kept strictly confidential. Write Box 1714, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

Fireman for 16 years at Cooks Brewery, which closed, would like job at Brewery or Power Plant. Have had some engine-room experience. Box 1715, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

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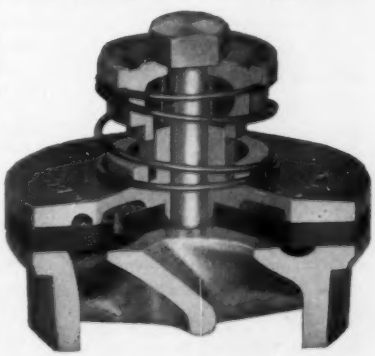
It Pays

SIMS INCLINED PORT ROTATING PUMP **VALVES**



Guaranteed to:

1. **REDUCE Seat and Disc Wear.**
2. **INCREASE Pump Capacity.**
3. **REDUCE Maintenance Costs.**
4. **WORK Efficiently in Light or Heavy Liquids.**

Sims Valves are available for all reciprocating pumps from stock.

Write for New Catalog PE-8

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PUMP VALVE CO., INC.
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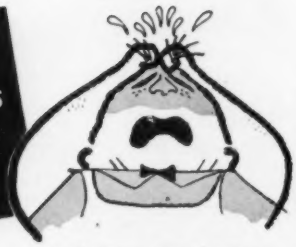
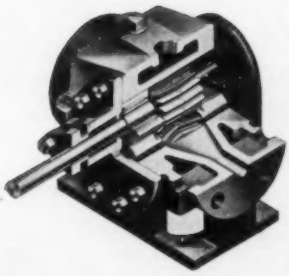
DON'T GIVE UP
when viscous liquids cause pumping problems . . .





An SK Steam Jacketed Gear Pump can restore that old equanimity—keep the brass happy and you smiling.

Engineers and production men in many varied industries are using SK Steam Jacketed Herringbone Gear Pumps to handle viscous materials of many types—heavy fuel oils, asphalt, vegetable shortening, glue, and others.

Take a tip from these folks. Send for a copy of Bulletin 17-A which describes SK's line of pumps. Or, acquaint us with your problem. We'll help.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS

2221 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus: Ask for Condensed Bulletin J-1.	Rotameters & Flow Indicators: Ask for Condensed Bulletin 18-RA.	Valves: Ask for Condensed Bulletin V-1.	Heat Transfer Apparatus: Ask for Condensed Bulletin HT-1.	Gear Pumps: Ask for Bulletin 17-A.

For more data circle 574 on Post Card

Sign Your

DECLARATION OF INDEPENDENCE

☆

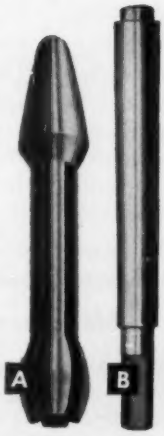
Buy U. S. Savings Bonds!

Wilson Tube Cutter

CUTS COSTS!

The Wilson Tube Cutter costs two to eight times less than competitive tools. You also get a tube cutter with eight exclusive features:

(1) It has fewer working parts. (2) It can cut non-ferrous tubes in under four seconds. (3) You can chuck it into your own air or electric drill. (4) It has a replaceable spacer collar to adjust for tube thickness. (5) The cutter bit retracts after withdrawal of the cutter. (6) You have a choice of round or taper shank in smaller sizes. (7) To operate, you insert the cutter in the tube, switch on the power, and press forward. (8) It takes the punishment of constant use.



A Tube Pilot guides tubes through baffles and far sheet when retubing.

B Tube Knockout tool for manual or mechanical use.

It makes good sense to buy the Wilson Tube Cutter and accessories. For some more suggestions that will cut your tube maintenance costs, write for Wilson comprehensive Tube Expander Catalog. For tube cleaners, send for Wilson Catalog 77.

Don't Forget!

For cleaner cleaning WILSON TUBE CLEANERS

For easy, accurate tube rolling WILSON TUBE EXPANDERS

Representatives in principal cities

THOMAS C. WILSON, INC. • 21-11 44th Ave., Long Island City 1, N.Y.

Cable address: "Tubeclean", New York

.TW 851 **WILSON**

TUBE CLEANERS • TUBE EXPANDERS

For more data circle 576 on Post Card

NEW JONES & LAUGHLIN WATER-TREATMENT PLANT *with* AUTOMATION *and* EQUIPMENT *by* INFILCO

cuts hardness from 268 to 2 p.p.m. –greatly reduces labor costs

The Monongahela River is the source of raw water for steam generating plants of Jones & Laughlin Steel Corporation. Total hardness ranges up to 268 p.p.m.—clarity and degree of acidity fluctuate widely.

Using a cold-process, lime-batch plant, hardness could only be reduced to about 1.5 grains per gallon, or 26 parts per million.

INFILCO equipment, including C.-A.-P. SYSTEM® instruments was chosen for greater efficiency and automatic operation. The new plant produces water averaging about 0.1 grain per gallon —2 p.p.m.—hardness. It has cut labor costs more than 50% and made better service possible. And the end result — steam production — is more efficient and economical, too.

This is another example of INFILCO leadership in this field — further proof that

Infilco knows how

to help you solve your water-treatment problems. For complete information about this interesting installation, write today for Reprint No. 70-PE-11.

INFILCO INC.

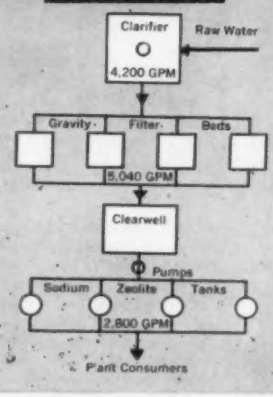
General offices, Tucson, Arizona

*The **one** company offering equipment for **all** types of water and waste treatment*

5611

FIELD OFFICES THROUGHOUT THE UNITED STATES AND FOREIGN COUNTRIES

INFILCO EQUIPMENT automatically



...MEASURES flow, maintains constant water level, keeps amounts of chemical proportional, removes sludge.

...EQUALIZES water passage by flow control and loss-of-head control, maintains same flow rate, controls backwash.

...PUMPS water to softening units and then meters it to five 175,000-lb./hr. boilers for steam generation.

MAIN PLANT COMPONENTS AND AUTOMATION

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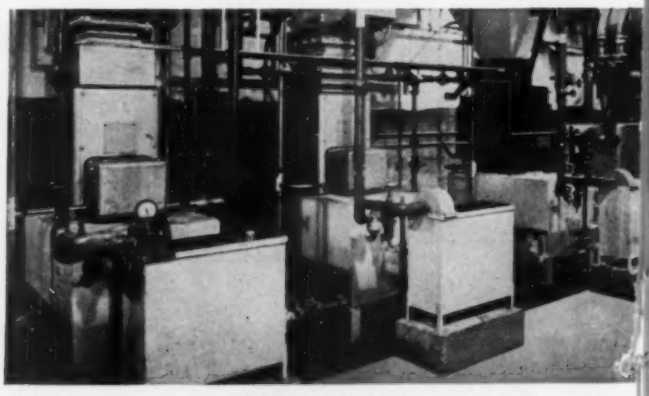

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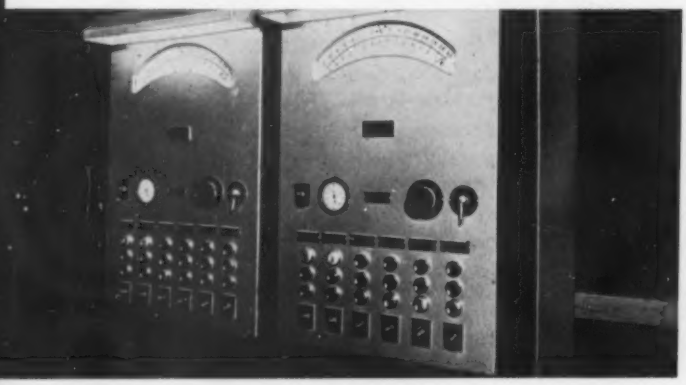
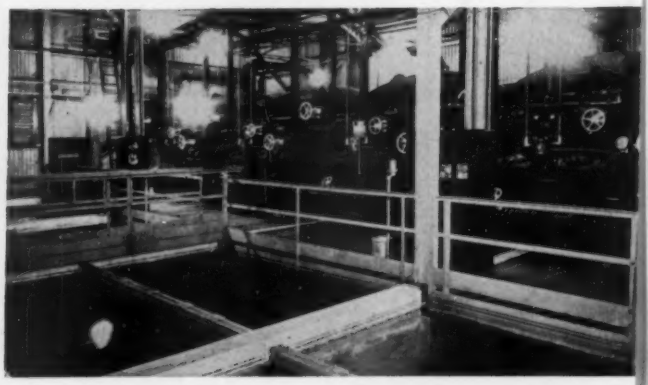




ELECTRICALLY CONTROLLED SODIUM-ZEOLITE SOFTENING UNITS

For more data circle 577 on Post Card

CHAPMAN
Tilting Disc Check Valve

There, in a nutshell, is the story of a Chapman Tilting Disc Check Valve . . . quick as a cat, quiet as a mouse. It's designed that way. It's built that way . . . for fast, sure, quiet action. Or, in other words, it's yours for best performance at lowest long-range operating costs.

With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

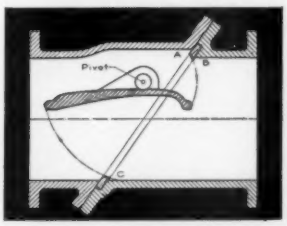
To put it briefly, with a Chapman Tilting Disc Check Valve, there's little or no maintenance even under severe operating conditions.

For Chapman Tilting Disc Check Valves in iron and steel . . . valves for handling fluids or gases under a wide range of pressures . . . valves for replacement or new piping systems . . . just check our Catalog 30-A. It's yours for the asking. Send for it now.

The CHAPMAN Valve Mfg. Company
INDIAN ORCHARD, MASSACHUSETTS

Never a Flutter, Never a Slam!

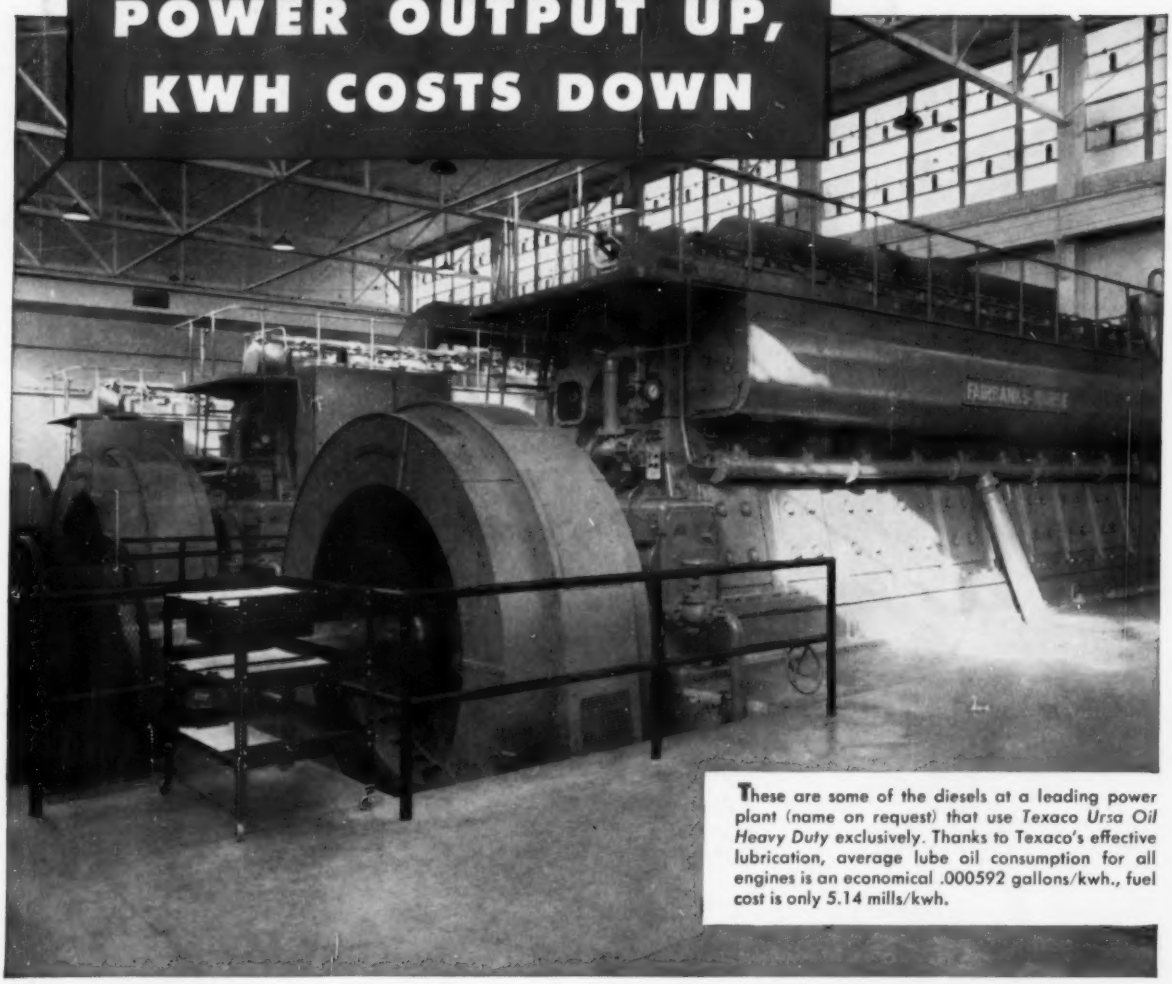
Designed and Built for Quiet Efficient Operation



In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.

For more data circle 578 on Post Card

HOW YOU CAN KEEP POWER OUTPUT UP, KWH COSTS DOWN



These are some of the diesels at a leading power plant (name on request) that use *Texaco Ursa Oil Heavy Duty* exclusively. Thanks to Texaco's effective lubrication, average lube oil consumption for all engines is an economical .000592 gallons/kwh., fuel cost is only 5.14 mills/kwh.

LUBRICATE your engines with one of the world-famous *Texaco Ursa Oils*. It's your best assurance of full-power, dependable performance at low maintenance costs.

There is a complete line of *Texaco Ursa Oils*—especially refined to make diesel, gas and dual-fuel engines deliver *more power* with *less fuel* over *longer periods* between overhauls.

Operators everywhere have found that *Texaco Ursa Oils* prevent harmful deposits and stuck rings, assure proper compression and combustion. These outstanding benefits are so consistently delivered that—

For over 20 years, more stationary diesel h.p. in the U. S. has been lubricated with Texaco than with any other brand.

Whatever the type of your engines, whatever the operating conditions—there is a *Texaco Ursa Oil* to assure highest efficiency at lowest possible cost. Let a Texaco Lubrication Engineer help you make the best selection.

Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO URSA OILS

FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

For more data circle 579 on Post Card